Registered as a Newspaper in Ceylon

H.DEC.AS.C
As.3

VOL. CVI. No. 1
JANUARY TO MARCH, 1950
(1st QUARTER, 1950)

The Tropical Agriculturist

The Agricultural Journal of Ceylon

Founded in 1881
by the late MR. JOHN FERGUSON, C.M.G.

Published by
The Department of Agriculture
Peradeniya, Ceylon.

The

Tropical Agriculturist

VOL. CVI PERADENIYA, JANUARY–MARCH, 1950 No. 1

Page

Editorial 1

ORIGINAL ARTICLES

Amino-Acid Analysis of Cereal Protein. The Nitrogen and Threonine contents of Ceylon Cereals by N. G. Baptist, Ceylon University 3

Some considerations of the African Soils Conference, 1948, by D. Rhind .. 7

DEPARTMENTAL NOTES

A note on the Cultivation of Singapore Jak by A. V. Richards 12

REVIEWS

The Pineapple Industry of the Hawaiian Islands by F. C. Cooke 14

SELECTED ARTICLES

The Retention of Phosphates by Soil by Alan Wild 15

MEETINGS, &c.

Minutes of the 4th meeting of the Central Board of Agriculture held on November 14, 1949 27

Minutes of the 107th meeting of the Coconut Research Scheme 42

Minutes of the 99th meeting of the Rubber Research Scheme 44

RETURNS

Animal Disease Returns, January to March, 1950 46

Meteorological Returns, January to March, 1950 49

The
Tropical Agriculturist
JANUARY TO MARCH, 1950

EDITORIAL

INTERNATIONAL CO-OPERATION IN SCIENTIFIC RESEARCH

IN the sphere of international co-operation scientific research is one of the most important subjects. The variety and complexity of modern science, the enormous cost of research on a large scale, the extent of repercussions of the discoveries continually being evolved are such as to make it essential that countries shall pool their efforts and jointly combine to make the best use of the results. It is no longer possible for the individual or for the isolated state to achieve the best results without the fullest contact and exchange of information and materials with others in the same field. No matter how highly qualified a worker may be or how well equipped his laboratories, working in isolation his efforts will be severely limited. Team work always has and always will produce results out of proportion to the numerical size of the team. In principle everybody is agreed. There have been several international conferences lately on agricultural and related subjects, such as the International Rice Commission, the Conference on Soils in Australia and the African Soils Conference in 1948 in the Belgian Congo, a conference on the adaptation of European breeds of cattle in the Tropics at Delhi this year and many more. The number of such conferences and the extensive documentation each involves sometimes gives rise to the criticism that they absorb too much time. This criticism must surely only apply where there are too few research workers for the tasks in hand, where their temporary absence from their laboratories seriously interferes with programmes of work, and where the labour of documentation falls on a few individuals who naturally grudge the time taken from their normal duties.

We do not consider that conferences are at present too numerous. One of the most important functions of such meetings is that they bring together a group of specialists and research workers who would otherwise never meet and whose contacts would only be through their published results, often obscured by language barriers. These personal contacts are of the greatest value to the research workers themselves, who are thus

enabled to exchange up-to-date information, much of which is frequently never published or only after long delays, and who are able to smooth out mutual difficulties. Very often matter which appears too simple to warrant publication in one country is of prime importance to another. An exchange of views between specialists of different schools of thought cannot but be fruitful of good. Such conferences are best when not too large and when they do not involve very elaborate documentary preparation which detracts from the normal work of participants and may render the discussions too diffuse. The results which are derived from such meetings cannot be assessed in money and often are not susceptible to detailed reporting. Those who have participated in such meetings are in no doubt as to their value, more especially for workers in countries where single specialists must follow their investigations in comparative isolation. Even though the interruption of the normal duties of such men is greater than when there is a large team to pick from, the stultifying effect of long continued isolation is such that periodical contacts with fellow workers is a practical necessity and the cost of attendance slight compared to the advantages.

The character of international conferences should be such that there is the maximum chance for participants to discuss their own problems and exchange ideas. The formal programme should not be so full that they must spend the entire time in committees and neither should the social side make attendance at functions obligatory under pain of perpetrating an international discourtesy. There should be ample opportunity for exchange of ideas in an atmosphere of that calm characteristic of a research laboratory.

It must be admitted, however, that much remains to be done to pass from words to deeds and that in all too many cases the reports of international conferences are full of hopes, the implementation of which rests on individuals or on Governments whose representatives at the conferences must labour to convince their country of the wisdom and need for action.

There is a great deal of repetition and overlapping in research, more particularly in applied research, which international agreement might largely reduce. The drawing up of programmes of research on matters of common interest, the fixing of their order of urgency and their allocation to the most suitable institutes and personnel would economize staff and money while, with a suitable organization for collection of results, there should be no loss of efficiency; rather the reverse. The diversity of training of research workers under such an arrangement might have considerable advantage in bringing to bear a wider approach to problems.

Such an arrangement would probably entail international financial provision for the work, in part at least, but since the countries involved may be presumed to spend some money on isolated work at present, the additional obligations, if any, should not impose insuperable obstacles.

ERRATA

PAGE 3, Vol. CVI, No. 1, of January to March, 1950, in line 10–11, for " appreciable differences in some of the essential amino acid contents ", read " appreciable differences in some of the amino acid contents ".

Amino-Acid Analysis of Cereal Protein–the Nitrogen and Threonine Contents of Ceylon Cereals*

N. G. BAPTIST
BIOCHEMICAL LABORATORY, UNIVERSITY OF CEYLON

RECENT research based on more accurate methods of analysis has established that considerable variations may exist in the nutrients present in different varieties of the same cereal. This appears to apply particularly to protein and amino-acid contents and to the B-group of vitamins. Thus for example, while English Wheats have an average value of 8·9 per cent. protein, Manitoba wheats average 13·6 per cent. protein[1]. Similarly considerable variation has been reported in the amino-acid content, of different varieties of wheat[2], and in the amino-acid cystine in different varieties of Soyabeans [3]. Kik [4], in a comprehensive study of the nutritive value of rice has shown appreciable differences in some of the essential amino-acid contents of five varieties of N. American rice. Appreciable differences were also seen in the content of some of the essential amino-acids. The fact that rice forms the bulk of the cereal consumption in this country coupled with the fact that whole rice has a lower protein content than other world cereals such as wheat, oats, and barley, suggested that a detailed investigation of the protein and amino-acid contents of local rice varieties might yield a pointer to selection of the most profitable varieties for any given set of conditions. The Nitrogen contents of six rice varieties were accordingly determined, and for a start with the more detailed analysis the threonine content was determined by the per-iodate oxidation method [5].

Experimental

The paddy grains were autoclaved in steam at 15 lb. for 15 minutes, dried in air at room temperature, and the husks removed by hand to prevent fracture of the grain or loss of pericarp and germ. The whole grains were powdered, sieved through 90-mesh, and dried at 100°C. The materials were then fat-extracted with petroleum ether 40-60°C., and redried at 100°C. Estimations of Nitrogen were carried out on the fat-extracted materials as well as on some of the raw materials, by the micro-Kjeldahl method, according to Chibnall *et al* [6]. The differences in N contents between fat-free and raw materials were negligible. Protein contents were calculated on the basis N × 5.7.

Rice proteins are mainly composed of glutelins and the purest glutelins prepared from wheat have been found to have N contents much higher than 16 per cent. The factor 5.83 is now employed for the whole wheat kernel[7] but in practice, the factor 5.7 is commonly used to convert cereal Nitrogen to protein and this is approximately correct. The factor 6.25

* This paper was read at the Proceedings of the Ceylon Association of Science, December 1949.

should not be applied to cereals, although it is correct for a number of other foods. Threonine determinations were carried out by the technique of Rees[8] as described in a previous paper[9].

The Extraction hydrolysate referred to in the table was prepared as follows:—

Approximately 1 gm. of the material is heated on the water bath with 100 c.c. N/2 HCl and then boiled gently overnight. The filtrate and washings are evaporated in vacuo to dryness several times with the addition of water. The final residue is taken up in 20 per cent. HCl (50-100 c.c.) and boiled gently for 20-24 hours. The acid is removed in vacuo as completely as possible and the residue taken up in water and made to volume.

Results

TABLE I

Per cent. Protein (N × 5.7) in Ceylon Cereals (on anhydrous basis)

Cereal		*Fat-extracted material*		*Raw material*
Rice				
	Devareddiry	10.32		
	Madael Seed	9.80	...	9.86
	Velai-Illayankalan	9.46		
	Sulai	8.89		
	Pokkali	8.49	...	8.55
	Pachaiperumal	7.53		
Sorghum				
	Kelo	11.00		
Millet				
	Kurakkan	7.18		

TABLE II

Threonine content of Ceylon Cereals

Values given are Threonine N as % of total N

	Fat-free Material		*Raw Material*
Cereals	*Direct Hydrolysis*[1]	*Extraction Hydrolysis*[2]	*Direct Hydrolysis*[1]
Rice			
Devareddiry	2.47 ...	2.48	
Madael Seed	2.58 ...	2.43 ...	2.51
Velai-Illayankalan ...	2.62 ...	2.38	
Sulai	2.40 ...	2.43	
Pokkali	2.57 ...	2.49 ...	2.58
Pachaiperumal	2.45 ...	2.51	
Sorghum			
Kelo	2.42 ...	2.26	
Kurakkan	3.25 ...	3.16	
Rice white	...	...	2.61[3]
Wheat	...	...	2.41[4] / 2.18[3]
Barley	...	...	2.66[3]
Whole Egg	...	...	3.63[4] / 4.35[3]

[1] Hydrolysis with 20% HCl for 20-24 hrs.
[2] Hydrolysis of N/2 HCl extractable material with 20% HCl for 20-24 hrs.
[3] Horn *et al.* J. Biol. Chem. *169*, 742 (1947).
[4] Block and Bolling. Adv. in Prot. Chem. Vol. *2* (1945).

Discussion

In spite of the wide differences in protein contents, no appreciable differences are observed in the content of threonine, one of the essential amino-acids. It should be noted, however, that as the results are expressed in terms of amino-acid nitrogen as a percentage of total nitrogen, the threonine content varies from one variety to another in direct proportion to the variation in protein content. In other words, though there are quantitative differences in the different varieties, the protein present appears to be qualitatively the same. It would, however, be premature to regard such a conclusion as established from the analysis of one essential amino-acid and further work on the other essential amino-acids is in progress.

The Nitrogen contents of the six varieties of rice analysed show appreciable differences. The question of what proportion of the total nitrogen of a foodstuff represents protein is one that is still open to debate. Certainly the total nitrogen includes in addition to protein and its direct breakdown products, small proportions of other nitrogenous materials such as purines, amides, amino sugars and inorganic nitrogenous compounds. McCance and others[1] give the following figures for purine nitrogen in two varieties of wheat :—

Wheat	*g.N/100g.*	*g.Protein/100g.*	*Purine N. mgs.*
Manitoba ...	2.29 ...	13.62 ...	55(2.3% of T.N.)
English ...	1.56 ...	8.89 ...	31(2.0% of T.N.)

A further point that has puzzled nutrition workers in the past and that continues to baffle scientists today is that though (as far as present methods are able to ascertain) all the nitrogen of many foodstuffs, e.g., potato, is definitely not protein N, yet the whole foodstuff is as efficacious in promoting growth as the purely protein fraction [10]. It is considered therefore that in the case of cereals at any rate, it may be safely assumed that 90 per cent. or more of the total N represents protein or compounds equivalent to it for nutritive purposes.

At a time like this when this country is setting itself to the task of becoming self-supporting in the matter of its rice supply, it is a matter of importance to ascertain both from the qualitative as well as quantitative point of view what constitutes the best varieties.

In this connection, it is worth mentioning that the ordinary process of hulling as practised in this country removes the bulk of the outer layers of the grain which contains proteins which are biologically superior to the proteins of polished rice. Kik has shown in determinations of the biological value of the proteins of whole rice and polished rice that although both had similar highly digestible proteins, whole rice protein showed smaller losses during metabolism with a resulting better utilization and superior growth promoting value. The disadvantage of the lower protein content of whole rice as compared with other world cereals can be partly neutralized by a greater use of whole rice as compared with polished rice in the diet. This is especially true of the diet of low-income groups of people where rice must provide a considerable proportion of the daily protein intake. The milling of whole rice may result in a decrease of up to approximately 17 per cent. of the protein content and also in the loss of essential amino-acids which are present to a greater extent in the bran (pericarp and

aleurone layers) than in the endosperm. On the other hand the practical difficulties of storage of unpolished as against polished rice are enormous owing to the liability to pest infestation and poor keeping qualities of the whole grain. It is suggested that as a suitable mean, a standard process of undermilling be adopted for large-scale milling, as for example at the various Government Rice Mills; but the use of home pounded parboiled rice be encouraged as far as possible by propaganda and education. It may not be inappropriate at this point to mention the increasing prices which we are called upon to pay in the foreign market for supplies of cereals and cereal flours. To the nutritionist, a point of obvious importance is the content of nutrients of the proposed purchase. But for the layman, wheat flour is wheat flour and rice is rice, no matter what its source may be. It will be seen from a glance at the tables provided above, that at the same price, the purchase of Manitoba wheat to English wheat is an obviously better buy. To my knowledge, such considerations do not enter into the food purchases of this country and it is to be hoped that at least with the operation of the Food and Drugs Act, such evaluations of nutrients would be commenced for statistical purposes if not for economic reasons.

Summary

The Nitrogen and protein contents of six local rice varieties, of Sorghum and of Kurakkan have been estimated.

Estimations of one of the essential amino-acids, namely threonine, showed no appreciable differences in the quality of the protein in the different rice varieties. The differences in total protein, however, are appreciable. It is suggested that the nutrient content should be a deciding factor in the purchase for domestic consumption of cereals and cereal flour from foreign sources.

Acknowledgment

I have to thank the Director of Agriculture, Ceylon, for the specimens of cereals used in this work.

REFERENCES

1. McCance *et al.*, B. J. *39*, 213, (1945).
2. Csonka, J. B. C. *118*, 147, (1937) Cereal Chem. *14*, 397, (1937).
3. Hamilton and Nakamura, J. Agric. Res. *61*, 207, (1940).
4. Kik, Univ. of Arkansas, College of Agric., Agricultural Experiment Station. Bulletin No. 416, (1942).
5. Rees, Biochem. J. *40*, 632, (1946).
6. Chibnall *et al.*, B. J. 357 (1943).
7. Bailey. The constituents of wheat and wheat products—Reinhold publishing Corpn., New York (1944).
8. Rees, Biochem. J. *40*, 632, (1946).
9. Baptist, Proc. Cey. Assn. of Sci. Pt. 2, 1947.
10. Chick and Slack, B. J. *45*, 211, (1949).

Some Considerations of the African Soils Conference, 1948

BY

D. RHIND

THE forthcoming International Conference on the Utilization of Soils in Tropical Regions, scheduled to take place in Ceylon in 1951, prompts attention to a similar conference held at Goma, Belgium Congo, three years previously. The records of the Goma Conference are fully published in the *Bulletin Agricole du Congo Belge*, Vol. XL (1949) and occupy nearly 3,000 pages, recording in full 180 papers submitted on a great variety of subjects affecting land use in Tropical Africa, as well as summaries of discussions and resolutions passed by various sections. The conference was divided into five sections:

1. General and regional study of soils.
2. Causes and signs of soil degradation.
3. Cultural systems in relation to soil conservation.
4. Development of agricultural mechanization and the use of manures.
5. Social and economic problems in relation to soil conservation.

It will be at once apparent that the scope of the conference was very wide and covered all matters which may affect, directly or indirectly, the conservation of the soil and its use. The first point which was emphasized by the Secretary-General in his concluding summary was the fact that many contributions over-lapped several specific subjects, as was inevitable considering the all-embracing character of soil utilization, and that there was abundance of information needing correlation. The numerous papers submitted revealed the importance of adjusting soil conservation methods to local conditions and of adopting a technique suited to each case. Despite this need for intimate adjustments the principle was accepted that territorial or political boundaries should not interfere with soil preservation and that the combined efforts of all countries treating the problem on a geographical basis are needed. In this respect Ceylon is fortunate in having control of the whole area influencing her soils. The African problem, in common with those of other continental areas, requires international combined action which is recommended should be through an Inter-African Bureau to be set up in Paris.

The classification of soils and their mapping on a basis of suitability for various uses received great emphasis because of the importance of preventing improper treatment of soils by individuals or bodies not conversant with the whole problem or not willing to conform to the requirements of safety of the soils. This aspect received recognition in a recommendation to set up an Inter-African Pedological Service to unify soil analysis methods, lay down standard methods of soil classification, description and soil use mapping. (Recommendation No. 2.)

Arising out of the preceding two recommendations the conference regarded the setting up of permanent regional committees of technicians as essential to delimit soil conservation zones and devise plans for proper land use. (Recommendation No. 3.) The importance placed on co-ordination between adjacent administrations for land use control on a wide basis was very marked and the essential character of continuity over long periods found expression in the decision to hold periodic conferences, the next being scheduled for 1955. (Recommendations Nos. 3 & 4.)

The ineffectiveness of methods of persuasion in inducing people to practice correct methods of soil preservation was evident from the discussions and culminated in Recommendation No. 5 envisaging enforcement by legislative action of methods of soil conservation and land use on all classes of land under whatever form of tenure, though care should be taken to obtain the maximum co-operation of the people that is possible. Desire for co-operation should not, however, be carried to an extent that would permit continued misuse of land, even if ejection of the inefficient occupant and resumption by the State were the only remedy. This lead naturally to Recommendation No. 6 on the need for integration of African agriculture with world economy and the change of primitive systems of land ownership and land use into a stable system of grouped societies capable of being controlled in their land use activities. The bearing of this recommendation on the fragmentation of holdings and the scattered *chenas* of Ceylon needs no emphasis. The resolution on this subject passed by Section V may be quoted in full (pp. 2506-7) :

" This conference, being of the opinion that if African agriculture is to fulfil its proper role in world economy, it can no longer be developed upon the basis of small individual family holdings relying upon the hoe and family labour, and being also persuaded that any national land utilization policy must be based on some economic and social unit more really related to the topography of the countryside than the individual peasant holding, and that modernization of methods of production such as mechanization, the use of artificial fertilizers, insecticides, and the efficient processing of primary produce must be anticipated, has reached the following conclusions :

(*a*) that agricultural development must be based on some form of grouping of the native cultivators;

(*b*) that ultimately land utilization and conservation of natural resources will be assisted by devolution of responsibilities on to social and economic units sufficiently small to provide for intimate association with the land, but large enough to allow of land allocation to its optimum use and the organizational development of the producers along modern and efficient lines;

(*c*) that an efficient system of land tenure which provides for the group use of certain proportions of the land, such as permanent pastures and forest, but which also allows of individual right of use of arable land, is essential to a proper respect for and pride in the land;

and recommends to the Governments concerned :

(1) that studies of native systems of land ownership and land tenure should be actively pursued in all territories with a view to them being given legal sanction when they are in accordance with conclusion (*c*) above, or to their modification when necessary to meet the requirements of this conclusion. In these studies the importance of associating with them representatives of the native people with a knowledge of local custom is stressed;

(2) that on the basis of the knowledge already acquired as the result of research so far carried out, the Governments so concerned should be urged to establish in representative areas, pilot schemes of group cultivation under adequate European control and direction, with a view to developing prototypes of agricultural development suitable for adoption by the native population ".

The essence of this resolution may be found in the Ceylon Agricultural Department experimental dry farming colony at Kurundamkulam and in the schemes designed to settle people on the land, with safeguards against subsequent fragmentation and with such help and guidance as will enable them to farm profitably without detriment to the soil.

The foregoing six general recommendations cover the whole subject of soil use and define the views of the 150 delegates on the importance of preserving the soil and on the lines along which action must be directed in Africa. There follow a number of resolutions of a more specific and technical character, which are reviewed below.

The preservation of the vegetal cover as a soil protection measure was naturally stressed and the first of the technical resolutions (No. 1) records the importance of reserved forests, particularly those where clearance might result in soil degradations. The need to adopt silvicultural methods for improvement of the forest in rotation with food crops (the forest fallow of the *chena* system) was stressed, both from the point of view of improving the humus status of the soil and of the value of the timber.

The menace of bush fires, which in Africa can occur regularly on an enormous scale, received serious consideration and, while running fires are heartily condemned, the need to study experimentally the effects of bush fires was agreed upon and the impossibility of eliminating such fires at once from the present system of African agriculture was admitted. The danger of invasion of the forest by lanes of bush fires, whereby the bush flora can become established, lead to the advice that clearance of the forest on bush margins should be stopped. (Resolution No. 4.) There is need for encouraging mixed farming with a limitation of the ' livestock load ' to the capacity of pastures and an attempt to alter the traditional conception of cattle as a mere indication of wealth to one of a profitable industry. (Resolutions 5 and 6.) The same concept holds to a lesser extent in parts of the Dry Zone of Ceylon where wandering herds of inferior cattle cause damage to any unfenced crop and merely by their worthless existence enforce an expensive system of fencing. The unqualified condemnation of upland (*taungya*) rice on hill slopes may be appropriate to African conditions but would seem too sweeping for some parts of the Far East (Resolution 7

(*a*)), where this system is often the only alternative to no land use at all and where its evil features are not pronounced so long as the cycle is not too short. There is also to be considered the long-term view of the value of deposited silt from great rivers, as for example the deltas of the Irrawaddy and the Mekong. Without past erosion many millions of acres of fertile rice land in Asia would not exist today. It is necessary to consider whether soil is being removed from thickly populated or very sparsely populated areas and whether it is being totally lost or merely transported to a more convenient place. This may appear heretical but in regions where neither land nor forest have value the removal of the soil to places where it can be put to use seems to be advantageous while on a long enough cycle the forest suffers little. It cannot be denied that the alluvial deposits of such rivers as the Irrawaddy and Mekong are of much greater value than the forest-clad maze of hills whence they come. Should the cycle be too short the forest degrades into bamboo brake over huge areas of the hinterland of the Indo-Chinese area but bamboo brake is a good soil preserver and with the cessation of *taungya* cutting imposed by the bamboo invasion the scanty population migrates and ultimately the forest regains its domain. The condemnation of this *taungya* practice may be justified under African conditions but it appears more doubtful in certain regions of Asia. Where the transported soil is totally lost, as in Ceylon, then it is a system to be wholly condemned.

On the question of mechanization of tropical agriculture, the conference was apparently in a divided state of mind, wishing to promote mechanization but fearful of its possible deleterious effects on soils. This probably prompted the recommendation (No. 9) which insists on the necessity for " pursuing and hastening researches on the effects on the soil of mechanized cultivation " utilizing the services of all branches of soil science with a view " to solving the problems of soil stability and fertility by the adoption of methods of husbandry in keeping with the basic tenets of soil conservation ". The same resolution goes on to point to the need to reduce the demands on the soil (particularly rice soils) by a study of mechanized cultivation and water management. The conference was clearly concerned at the possible dangers inherent in large-scale mechanization and felt in need of much more precise information. The development of special tractors and implements to suit tropical conditions and techniques differing from those appropriate to temperate regions is mentioned, as well as the importance of integrating the research on machinery and soils. Too often the two develop in comparative isolation so far as tropical regions are concerned.

On fertilizers the conference showed comparatively little interest in artificials but emphasized, as was to be expected, the importance of " restitution to the soil of organic matters of all kinds ". (Resolution No. 10.) In regions where density of population is a menace to soil conservation it is recommended that high priority be given to well-planned schemes involving social and economic studies, specialization of agriculture, methods of diverting population to other occupations or regions by promotion of local industries and adoption of intensive as opposed to extensive agriculture. (Resolution No. 11.) The conference clearly recognized that social and economic conditions cannot be divorced from soil conservation.

The effect of land use systems on the water cycle received special emphasis and the initiation of researches, unencumbered by considerations of immediate profit, into problems of water and soil conservation and the influence of various land use practices on water supplies, forms the subject of Resolution No. 13. The co-ordination of the studies of meteorologists, hydrologists and soil conservation experts is separately recommended in Resolution No. 14.

The final resolution (No. 15) stresses the advantage of statistical methods over the empirical and subjective methods too often used hitherto. The importance of the statistical approach needs no emphasis to those who have learnt its value through use, but to others its value is often less apparent. The presidential address of Professor Mahalanobis at the 1949 Indian Science Congress amply covers this subject.

The above review is based on the condensed Report of the General Secretary of the Conference but as the object is only to give an outline of the results of the African Conference, those interested are referred to the full reports of the sections. The report contains many valuable contributions to soil management questions and deserves close study. While African conditions differ in many ways from those in Asia, certain general principles are brought into prominence and specific problems are discussed by a body of experts.

A Note on the Cultivation of Singapore Jak

A. V. RICHARDS, M.Sc. (Calif.), B.Sc. (Lond.), Dip. Agric. (Cantab.), A.I.C.T.A. (Trinidad)

HORTICULTURAL OFFICER, DEPARTMENT OF AGRICULTURE, PERADENIYA

JAK is easy to grow, and provides an important article of food which is highly relished by the poorer classes in the villages. They live on it during the season when food grains are in short supply. The fruit is used in nearly all stages of maturity. The tender fruit is finely chopped and made into a *mellum*, the mature but not ripe fruit is curried in coconut milk. or simply boiled with the seeds and eaten, while the ripe *peniwaraka* is relished as dessert.

The Singapore jak is an early bearing variety of the ordinary jak *Artocarpus heterophyllus* Lamk. The Johore jak is of a different species altogether, its botanical name being *Artocarpus Champeden* Lour. It is readily distinguishable from the ordinary jak by the presence of stiff brown hairs on the young shoots, and the overpowering durian-like odour of the ripe fruit which is generally ovid and small. The tree does not grow big, and its timber has hardly any commercial value.

The Singapore jak comes into bearing in about 18 months under favourable conditions in the low country wet zone, but may take two years or more at higher elevations. The fruit of this variety generally matures in large numbers during the off season from November to February. By planting both this variety and ordinary jak it should be possible to harvest fruits nearly all the year round. The fruit is a hard-fleshed *Waraka*, but seedling trees may produce soft-fleshed *Vela* fruits since they do not always come true to type.

PLANTING OF SEED

Jak seeds do not retain viability for a long period when exposed, and are best planted immediately on extraction from the fruit. They could be stored for sometime in coir dust or sand without losing viability, but if the cotyledons become dry and shrivel up they fail to germinate.

The seeds may be germinated satisfactorily in pieces of coconut husk containing enough soil to cover the seed, and planted in the field with the husk They may also be germinated in small bamboo pots or plant-supply baskets, but the young seedlings do not remain healthy for more than a month or so in such containers. If the seed is planted in seed beds the young plants should be transplanted before the food reserve in the cotyledons is exhausted, otherwise they often fail to recover from the shock of transplanting.

PLANTING IN THE FIELD

Elaborately prepared holes are not necessary for planting jak. Small holes $1\frac{1}{2}' \times 1\frac{1}{2}'$ would do, and they should be filled with a mixture of top soil and some compost or well rotted cattle manure if available. Planting is best done during showery weather at the beginning of the rainy season. If a dry spell prevails soon after planting, handwatering will have to be done till the plants are well established.

Jak plants require a minimum spacing of $25' \times 25'$ but for use as windbreak they may be planted closer at $18' \times 18'$ in double rows with the plants alternating in the rows.

The young fruit is liable to attack by the jak borer, *Margaronia caesalis* which hatches out as a caterpillar from the egg laid on the rind by the moth, and tunnels its way into the flesh. The damaged portion of the fruit is subsequently attacked by disease organisms which cause discolouration and rotting of the flesh. Protecting the newly formed fruit with baskets or dusting with gammaxene would help to reduce pest damage.

After the fruit is harvested the stalk should not be left on the trees to wither, but cut flush with the stem to encourage production of flowering shoots next season.

BUDGRAFTED JAK

Jak seedlings could be budgrafted successfully by the modified forkert method, using budwood of the previous seasons growth, but the budgrafted trees are difficult to transplant, and appear to take almost the same period as seedling trees to bear fruit. The only advantage is that they come true to type. On the other hand they are of no value for timber because of their low branching habit.

REVIEWS

The Pineapple Industry of the Hawaiian Islands

BY

F. C. COOKE, A.R.C.S., B.Sc., A.M.I. Chem. E.

(Price : Straits $ 5)

Special Bulletin, General Series, No. 32

Published by the Department of Agriculture, Malaya

October, 1949

THIS is a comprehensive review of one of the most important canning industries in the world. In 118 pages, it deals with the plantation and factory side of the industry, subsidiary industries and by-products, organization, staffing and labour relations; and it describes the all-important part which research now plays in modern industry. Its appendix, giving a list of publications and references, concerning pineapple-growing and the pineapple canning industry, is the most complete that has yet appeared.

The author describes how the pineapple industry of Hawaii started from very modest beginnings. The early canneries were housed in crude sheds; the fruit was cut up and prepared in very small quantities, and the cans made by hand. Gradually mechanical devices were introduced to speed-up production and improve the quality of the product.

Today, Hawaii is said to be responsible for 85 per cent. of the total world production of canned pineapple products and the total annual output now amounts to over 18 million cases. It has reached this pre-eminent position from small beginnings in less than 60 years through a dynamic policy of expansion, based on co-operative research, fostered by co-operative advertising, and soundly secured on the basis of interlocking finance, whereby sugar, pineapples, insurance, tourism, and banking are closely related for the mutual protection of their interests.

Research has played an increasingly important part in the development of the industry and its success appears to be primarily due to the exhaustive investigation of the problems of planting, processing and can-making by a large force of scientifically trained men and women, and by the strict control of field and factory operations by qualified technicians.

The overall expense of the agricultural and processing research carried out in Hawaii is estimated to be in the neighbourhood of Rs. 3,000,000 per annum for an industry based on an area of only 63,000 acres of pineapples, but yielding a gross revenue to the industry of approximately Rs. 200,000,000 per annum, i.e., $1\frac{1}{2}$ per cent. of gross revenue is spent on research.

Since the war, the demands by labour for wage increases have become more insistent and today the wages in Hawaii are at an astonishingly high level. Only by increasing mechanization has the industry been able to continue to produce at a competitive price. Fortunately, and no doubt owing to the American way of life, the workers have co-operated in the application of labour-saving machinery and labour-easing devices, and appear to prefer the use of machines to laborious physical labour. Mechanization has given them opportunities for entering the ranks of skilled employees at higher pay and there appears to be little risk of unemployment as production continues to increase.

The author found in the industry, a dynamic, unceasing and restless urge to discover new methods and new products; to secure ever greater efficiency; to initiate and show the way; and not merely keep abreast of new developments.

The Retention of Phosphate by Soil. A Review

ALAN WILD

(*Department of Agricultural Chemistry, The University, Reading*)

THE scope of the present review is limited to the evidence for, and the nature of, the retention of phosphate by soil. It does not include the numerous experiments that have purported to measure the availability to plants of the retained phosphate. The literature up to 1932 has been surveyed by Weiser (157) and some of the more recent literature by Midgley (95).

The following terminology will be adopted:—

' Phosphate ' refers to the anions which are formed from the dissociation of orthophosphoric acid or any of its salts.

' Phosphate sorption ' and ' phosphate retention ' are used synonymously and are taken to mean the removal of phosphate from solution by soil or by a soil constituent. No particular mechanism is implied. ' Phosphate adsorption ' and ' phosphate absorption ' are taken to mean the retention of phosphate at a surface and within a solid phase, respectively.

' Phosphate fixation ' is used to describe any change that the phosphate undergoes in contact with the soil, which reduces the amount that plant roots can absorb. It is understood that plant roots active in nutrient absorption can penetrate into the locality of the phosphate, that is, the phosphate is not positionally unavailable to the roots.

There is, unfortunately, a general lack of agreement on the meanings that should be associated with these terms, especially with ' phosphate fixation ', which is more commonly taken to mean the retention of phosphate from solution. As the retention of phosphate by soil and its decreased availability to plants are two processes that have quite different implications in agriculture, and in addition probably differ chemically, it is desirable to distinguish between them. This is done by using the above terminology.

GENERAL

The retention of phosphate by soil seems to have been first demonstrated by Way (153) in 1850, though Liebig (71) had anticipated the results 10 years earlier. Liebig stated, with regard to soluble phosphates, that ' in a few seconds the free acids unite with the bases contained in the earth, and a neutral salt is formed in a very fine state of division.' Way (153) found that the whole of the phosphate was retained when solutions of sodium phosphate in water, and guano in dilute sulphuric acid, were poured over a layer of calcareous soil. He thus found that a solution of phosphate differed from solutions of nitrate, chloride, and sulphate which passed through the soil with their concentrations unchanged. Way suggested that an insoluble calcium phosphate was formed. The importance of his observation was that water-soluble phosphate, as in the fertilizer superphosphate which was then coming into use, was retained by soil and not leached out in the drainage

Extracted from the *Journal of Soil Science* Vol. No. 2, January, 1950.

water. This was confirmed by Way when he carried out analyses of drainage water and found only small amounts of phosphate (155). In three of the seven samples he examined the amount was too small to determine. Subsequently, many similar determinations have been carried out and in general they yield the same results.

Some losses have, however, been reported. Robinson and Jones (119) carried out analyses of 6 soil profiles 10 years after the soils had been given a broadcast application of basic slag (200 lb. P_2O_5 per acre.) They could find little trace of the phosphate and concluded that it had been washed out of the top 18 inches of the soil by the heavy rainfall (35 – 75 inches per annum at the 6 centres) within 6 to 10 years after application. Some workers have reported losses from sandy soils (34, 81, 102), and others from soils receiving unusually heavy phosphate applications (61). Glentworth (53), observing that total phosphate is lowest and acetic acid soluble phosphate is highest in the gley horizon of poorly drained soils, suggests there might be a loss of phosphate in the ground water of poorly drained soils. Loss of phosphate may be serious where there is much run-off water (8, 64, 120, 127).

Apart from these special circumstances most of the phosphate remains in the soil. Its distribution within the soil is, however, of importance, because the phosphate should penetrate into the root zone of plants if it is to be of any value for crop growth. Way (154) and Voelcker (147) assumed that the water solubility of superphosphate should ensure not only the formation of a finely divided precipitate in soil, but also its adequate distribution within the soil. It has, however, been shown by a number of workers (8, 23, 24, 55, 58, 90, 104, 146, 150), that movement of phosphate within the soil is sometimes limited to as little as 2 or 3 inches, though it varies according to soil texture, amount of phosphate applied, rainfall, &c. Dyer (39) analysed the continuous wheat plots at Rothamsted and found that most of the phosphate that had been applied, and had not been removed in crops, was still present in the top 9 inches of soil. The penetration was greater when other fertilizer salts of farmyard manure had been used in conjunction with the superphosphate. This effect of organic matter has also been observed by others (43, 47, 91). Stephenson and Chapman (136) found evidence for the penetration of phosphate below the first foot in medium textured and light soils, but for practically no penetration below 6 inches in heavy soils. Phosphate that has been broadcast on a soil growing grass seems to move only very slowly from the surface (12, 94, 128, 132, 160, 162), though Doak (35) found appreciable penetration to 4 inches.

According to Weaver (156) some plants such as cereals and swedes may not send many roots into the top inch or two of soil. It is therefore not surprising that under some conditions at least the smallness of the movement of phosphate within the soil is responsible for the low response of crops to a phosphate application (24, 60, 94).

A. FACTORS AFFECTING PHOSPHATE RETENTION

1. Mechanical composition of soil.

It is generally accepted that most of the retaining power of soil for phosphate lies in its finer mechanical fractions, especially clay. Hibbard (59) found that the retention of phosphate by the three fractions that were retained on 1-mm., 40-mesh, and 100-mesh sieves and the fraction that passed through a 100-mesh sieve was greatest with the finest fraction and decreased as the particle size increased. Perkins, Wagoner, and King (106) divided a soil sample into six mechanical fractions (average diameter 0.06, 0.034, 0.016, 0.006, 0.003, and <0.003 mm.) and found that on a weight basis phosphate retention

increased with decreasing particle size, though on a surface area basis the reverse held. The phosphate was added as monocalcium phosphate. Owen (104) found a fairly close relationship between phosphate retention and clay percentage that could be described by the regression equation

$$\log y = a + b \log m,$$

where y = percentage retention, m = percentage clay, and a and b are constants. Other workers have found a similar relationship (7, 103). Coleman (20) found that the fine ($< 0.2\ \mu$) kaolinitic and montmorillonitic clay fractions of two soils sorbed over twice as much phosphate per gm. of clay as the corresponding coarse ($2 - 0.2\ \mu$) fractions. Using the minerals quartz, hematite, muscovite, phlogophite, biotite, pyro-phyllite, talc, montmorillonite, and kaolinite, Perkins and King (108) showed that the retention of phosphate increased with their fineness of grinding.

The effect of the chemical composition of the colloid fractions of soil is discussed later.

2. Phosphate concentration.

Russell and Prescott (123), Hibbard (59), Davis (27), Kurtz, De Turk and Bray (67), and Owen (104) have shown that the greater the ratio of phosphate to soil, the greater is the retention of phosphate. Laatsch (68) found that this also applies to NH_4 permutite. The relationship between phosphate retention and phosphate concentration has been shown to comply with the Freundlich adsorption isotherm (27, 67, 104, 123). Fisher (42) has pointed out that this does not necessarily imply an adsorption process, as precipitation processes also give results which fit the Freundlich adsorption isotherm.

3. Time and temperature.

Retention of phosphate differs from the retention of cations in that the reaction comes to completion only very slowly, if at all. It has been shown that with soil and with soil clay the initial stages of the reaction proceed rapidly, but the reaction, although getting slower, continues for many weeks (19, 27, 59, 67). A similar effect of time has been observed with kaolinite by Black (10), and with muscovite, montmorillo-nite, hematite, and limonite by Perkins (110). Black (10), Coleman (19), and Perkins (110) have shown that the amount of phosphate sorbed by the clay minerals increases much more with time at pH 3 – 4 than at pH 6 – 7. Scarseth and Tidmore (124), on the other hand, reported practically no difference in the amount of phosphate ' fixed ' after 1 hour and after 20 days. They used 0.05 normal and 0.1 normal sulphuric acid to measure ' fixation '.

The solubility in dilute acids of phosphate that has been added to soil has been shown to decrease with time. This has been demonstrated with 1 and 2 per cent. acetic acid and CO_2-saturated water (4), with 0.002 normal sulphuric acid (59, 97, 125), with 0.01 normal sulphuric acid (104), and with dilute acetic acid (50). Williams and Stewart (159) found a very rapid decrease in solubility in calcium lactate, magnesium bicarbonate, acetic acid, potassium bisulphate, citric acid, and sodium hydroxide solutions.

Under sterile conditions phosphate retention increases only slightly as the temperature is increased from 25°C to 35°C (158). If the temperature is increased up to 100°C the reaction proceeds much more rapidly (7, 57), though there is no evidence that the total amount of phosphate that can be retained is increased. If clay or soil is heated to much higher temperatures the hydrous minerals lose water and hydroxyl groups and their capacity to retain phosphate is decreased, though this does not apply to the hydrous aluminium oxides

(44, 66). The effect of temperature on the retention of phosphate under non-sterile conditions would be expected to depend on the relative rates of mineralization of soil organic matter, thus allowing release of phosphate, and on the absorption of phosphate by micro-organisms. Consideration of these factors is, however, outside the scope of the present review.

4. Effect of salts.

According to Liebig (72) sodium chloride, sodium nitrate, and ammonium salts increase the water solubility of calcium phosphate. Liebig argued that this increased solubility would still be exerted in the presence of soil and hence these salts would increase the diffusion of phosphatic fertilizers through the soil. Dyer (39) carried out analyses of the soil from the continuous wheat plots at Rothamsted and found that the salts potassium, sodium and magnesium sulphates had permitted greater penetration of the phosphate that had been applied as superphosphate. The phosphate that was retained was more easily soluble in 1 per cent. citric acid than on the plots not receiving these salts.

McGeorge and Breazeale (75) found that all the neutral salts that they tried decreased the solubility of rock phosphate and soil phosphate. Greaves (54) found that potassium chloride, sodium chloride, calcium chloride, calcium nitrate and calcium sulphate decreased the solubility of the phosphate of these two materials, but sodium nitrate, potassium sulphate and ammonium sulphate increased the solubility. Midgley (94) reported that potassium sulphate and ammonium sulphate slightly decreased and calcium hydroxide considerably decreased the penetration of superphosphate through a slightly acid silt loam, whereas the penetration was considerably greater in the presence of sodium nitrate.

On the other hand, Brown (12) showed that sodium nitrate or ammonium sulphate when added to a slightly acid subsoil in a laboratory percolation experiment resulted in practically no increase in the penetration of phosphate that could be detected by the method of Truog and Meyer (144). Also, Hibbard (59) found that calcium sulphate and calcium and magnesium carbonates considerably depressed the water solubility of the phosphate that had been applied to four soils, but sodium sulphate and ammonium sulphate had practically no effect and potassium and magnesium sulphates had only a slight depressive action.

Eriksson (40, 41), working with acidic Swedish soils, showed that the solubility and availability of phosphate are considerably lowered by the presence of potassium chloride. The effect increased with an increase in the salt concentration. A similar effect on phosphate solubility has been reported by Kurtz *et al.* (67).

There is, as yet, insufficient knowledge to explain these apparently contradictory results. In soils in which calcium phosphate is formed, the addition of a calcium salt which involves no change in pH would be expected to decrease phosphate solubility by the common ion effect, and other neutral salts would be expected to increase the solubility by lowering the activities of the phosphate and calcium ions. This latter effect is well known in analytical chemistry.

Cameron and Hurst (14) found that neutral salts depressed the solubility of aluminium phosphate. Similar observations were made by Karlsson and Mattson (65) with an aluminium phosphate precipitate at pH values above its iso-electric point (pH 5). At lower pH values the effect was reversed. This might explain the observations that have been made by Eriksson (40, 41) and by Kurtz and his co-workers (67).

Cameron and Hurst (14) reported that the solubility of ferric phosphate was decreased by potassium chloride and sodium nitrate, but slightly increased by potassium sulphate.

B. THE NATURE OF THE RETAINED PHOSPHATE

1. Iron and aluminium compounds.

Voelcker (147), in 1863, showed that a sample of clay soil containing only a small percentage of calcium carbonate was active in phosphate sorption. He concluded that this was due to the formation of insoluble compounds with the hydrous iron and aluminium oxides that were known to be present, and to the consequent precipitation of calcium phosphate. A few years later Warington (151) found that artificially prepared hydrous ferric oxide and alumina retained considerable amounts of phosphate from solution, even in the presence of carbon dioxide. He determined (152) the retention of phosphate by two soils which had been treated with dilute acetic acid to remove calcium, and found that the soil with the greater amount of iron and aluminium soluble in hydrochloric acid retained the greater amount of phosphate. He thought that ' in all soils containing a sufficient amount of oxide of iron or alumina, the phosphoric acid will be found in combination with these bases, and not as alkaline or alkaline-earthy phosphate '.

As it became known that the water-solubility of the phosphate in superphosphate was reduced by the presence of iron and aluminium compounds, so was it inferred that in soils also, which were known to contain these compounds, phosphate reacted to form insoluble iron and aluminium phosphates. Thus, Dehérain (30) thought that iron and aluminium phosphates were gradually formed in the unmanured experimental plots at Grignon. In 10 years there was a loss of 800 kilograms per hectare of P_2O_5 which was soluble in dilute acetic acid. Gerlach (48) shook samples of a soil in 1 per cent. acetic acid for periods of 3 hours, 24 hours, and 14 days, and found that 0.0103, 0.0079, and 0.0024 gm. P_2O_5 was dissolved. He attributed this diminution in the amount of phosphate extracted to a gradual sorption of the phosphate by iron or aluminium hydroxide after it had been dissolved from the more soluble phosphates. Similar observations were made by Russel and Prescott (123) in more exhaustive work.

In the last 30 years an intensive study has been made of the reactions that take place between soil and phosphate ions, and much of this work has been directed to elucidating the part played by iron and aluminium. These elements are found, in most soils at least, concentrated in the clay fraction. They both occur in the clay minerals themselves in octahedral linkage, and aluminium is found also in tetrahedral linkage. They can both occur as free hydroxides and oxides, aluminium as gibbsite $Al(OH)_3$ (1), and iron as hematite Fe_2O_3, geothite and limonite FeO(OH) (100), and as magnetite Fe_3O_4 (15). Except in acid soils the amount of each in the soil solution is small. Magistad (82) found that the concentration of aluminium in soil solutions is only likely to be greater than 3 p.p.m. outside the pH range 4.5—8.0. Aluminium ions are considered by some workers to be present as exchangeable cations as it is known that aluminium comes into solution when an acid soil is leached with a neutral salt (105). Iron is present in soil organic matter (149), and aluminium probably occurs similarly.

It is now established that iron and aluminium hydrous oxides can sorb phosphate under the conditions that normally exist in soils. This has been demonstrated with hydrogels (51, 70, 76, 96, 98), with ferric hydroxide (66), and with soluble iron and aluminium (46, 84, 98, 114, 139, 141). Ford (44) showed that goethite and bauxite, but not hematite, retained phosphate from solution and the phosphate retained by geothite had a very low solubility in 0.002 normal sulphuric acid. Perkins and King (109) found that limonite and one sample of hematite sorbed about 1 per cent. of their own weight of phosphoric acid, but another sample of hematite and magnetite sorbed practically no phosphate. Weiser (157) also reported that hematite sorbed no phosphate and thus differed from the hydrous oxides of iron such as limonite and goethite.

Thus, on *a priori* grounds the formation of iron and aluminium phosphate in soil would be expected. Support for this conclusion comes from four types of evidence.

(*a*) Correlations have been established between phosphate sorption and the amounts of iron and aluminium in soils.

Phosphate sorption has been shown to vary inversely as the SiO_2 $(Fe_2O_3 + Al_2O_3)$ ratio of soil colloids (83, 87, 124, 142). Gaarder and Grahl-Nielsen (47) showed that the phosphate sorption capacity of forty-three soils increased with the ratio of basoids to acidoids. Gile (52) found in a pot experiment that the efficiency of superphosphate decreased as the SiO_2 $(Fe_2O_3 + Al_2O_3)$ ratio of the soil colloids decreased.

The amount of iron and aluminium which is soluble in acids and the amount of phosphate that the soils sorbed have been correlated (3, 45, 118).

A correlation between the amounts of iron and aluminium and phosphate dissolved by dilute acids has also been established (19, 104, 148).

Metzger (93), using forty-two soil samples, found a significant correlation between total Al_2O_3, Fe_2O_3 (Al_2O_3 + Fe_2O_3) and phosphate sorption. He also found that the reduction in phosphate sorption capacity, due to extraction with 0.002 normal sulphuric acid, when expressed as a percentage of the original sorption capacity was correlated with the amount of iron that was soluble in the extracting reagent. He established a correlation between the percentage of total Fe_2O_3 that dissolved in 0.002 normal sulphuric acid and the percentage reduction in the phosphate sorption capacity that resulted from acid extraction. A similar correlation was not found with aluminium.

(*b*) Iron and aluminium have been removed from soils soil colloids and the effect on phosphate sorption has been studied.

Toth (142, 143) and Kelly and Midgley (66) used the hydrogen sulphide method of Drosdoff and Truog (38) to show that the removal of iron and aluminium oxides from soil colloid reduced phosphate sorption. The effect varied with colloid under investigation. A similar result has been reported by a number of workers (10, 17, 18, 20, 92) after the iron and aluminium had been removed by a slightly modified hydrogen sulphide method (145). However, it has never been proved that the clay minerals remain unaffected by the reagents used to extract iron and aluminium oxides and, in fact, Toth (143) and Dion (33) have reported evidence of such decomposition. Romine and Metzger (121) showed that the phosphate sorption capacity of soil was lower after extraction with 0.002 normal H_2SO_4.

Ghani (49) found that the addition of 8-hydroxyquinoline to soil reduced the sorption of phosphate under acid conditions. As 8-hydroxyquinoline was thought to block active iron and aluminium, this was taken as evidence for the formation of iron and aluminium phosphates.

(*c*) Iron and aluminium compounds have been added to soils and soil colloids and the effect on phosphate sorption has been studied.

Wolkoff (161) found that the addition of ferric chloride to a soil treated with rock phosphate reduced the amount of phosphate dissolved by 0.2 normal nitric acid. Aluminium chloride had no effect. Doughty (36) saturated a peat soil with iron and aluminium ions by leaching with solutions of ferric chloride and aluminium chloride. He found that both the iron and aluminium caused a considerable increase in phosphate sorption. The maximum sorption was at pH 2.5 following the ferric chloride treatment, and at pH 4.0 after leaching with aluminium chloride. Scarseth (126) found that a low-iron bentonite sorbed much more phosphate in the pH range 3.0—7.0 after being treated with a ferric chloride solution.

Davis (25, 26) reported that ferric chloride and aluminium chloride that had been added to soil-Ca $(OH)_2$-H_2O-air systems increased phosphate sorption especially at low pH values. In the sample treated with ferric chloride retention against 0.002 normal sulphuric acid and 0.1 normal sulphuric acid was also increased. He concluded that only at pH values lower than 4.5 are appreciable amounts of iron and aluminium phosphates formed that are insoluble in 0.002 normal sulphuric acid.

(*d*) Compounds formed during phosphate sorption have been identified by comparing the effect of pH on phosphate sorption with the known effect of pH on the solubility of iron and aluminium phosphates.

The effect of pH on the precipitation of iron and aluminium phosphates has been studied by Teakle (141). With iron, precipitation of phosphate was greatest at pH 3.0, and with aluminium, at pH 6.8.

With equivalent amounts of Fe . . . and PO'_4'', Doughty (36) found that the greatest precipitation was at pH 3.5-4.5 and Gaarder (46) at pH 2.0-3.0. Both workers reported that precipitation takes place up to at least pH 8 in the presence of a considerable excess of iron. With equivalent amounts of Al . . . and PO'_4'', Doughty found greatest phosphate precipitation at pH 6.8, and Gaarder at pH 3.6-4.0, but with an excess of aluminium Doughty found the pH range of greatest precipitation became 6.5-8.5, and Gaarder 4.5-6.5. Rathje (116) found that the greatest precipitation of phosphate by excess iron was at pH 3, and at pH 4 with excess aluminium.

Results from similar experiments have been obtained by Murphy (98) using ferric chloride and an iron hydrosol, and by Perkins and King (109) with limonite and hematite. McGeorge and Breazeale (76) and Stelly and Pierre (135) have reported results of the effect of pH on the solubility of iron and aluminium phosphate minerals. Stelly and Pierre found that the lowest solubility of the aluminium phosphate minerals wavellite and variscite was in the pH range 4.5-7.0, and of the iron phosphate minerals vivianite and dufrenite was in the pH ranges 6.0-7.0 and 3.0-6.0 respectively.

The first experiment to be reported that accurately related phosphate sorption of soil to the pH value was that of Roszmann (122). He found that the greatest sorption with the electrodialysed clay fraction of Putnam silt loam was at pH 3.0-4.0, with little sorption above pH 10.

Doughty (36) studied the retention of phosphate by a peat soil over the pH range 3-10 and attributed the retention at low pH values to iron and aluminium. Scarseth (126) found that the greatest retention of phosphate by an electrodialysed bentonite titrated with sodium hydroxide was at pH 6-7, which he thought was due to a reaction of the phosphate with the aluminium of the clay mineral. Allison (2) found a similar maximum at pH 6 with three soil colloids titrated with sodium hydroxide. He found another peak in the phosphate sorption pH curve at pH 3.0-3.5 which he attributed to the presence of iron and aluminium hydrous oxides, especially the former.

Black (10) working with Cecil Clay, found a maximum in the phosphate-sorption curve at pH 3-4, which he thought was due to hydrous iron oxide. He found that the amount of phosphate that was sorbed at this maximum was reduced by the removal of the free iron oxide, but it still remained appreciable. He also concluded that the maximum in the phosphate-sorption curve at pH 6-7, which he found with a sample of 2/μ kaolinite, was due to adsorption by free aluminium hydroxide. The aluminium was thought to come slowly into solution, especially under more acid conditions, because after 30 days' shaking the maximum had shifted to pH 5-6.

Coleman (18, 20) using montmorillonitic and kaolinitic clays showed that most sorption of phosphate took place at pH 3.0, but after removal of free iron oxides the sorption was reduced so to be about the same at pH 3.0, 7.0, and 9.5.

Mechanism of the reaction with iron and aluminium. Reference has already been made to the work of Russel and Prescott (123). These workers found that if soils were extracted with acids of low concentration (N/20 to N/10) the amount of phosphate that was extracted decreased with an increase in the time of the extraction. The action of dilute acids thus seemed to consist of two parts:

1. A direct solvent action of the acid on the phosphorus compounds of the soil that depended only on the concentration of the acid, and not on its nature.
2. A retention of the liberated phosphate that was greatest in the presence of mineral acids such as nitric and hydrochloric acids and least in the presence of organic acids such as citric and oxalic acids.

They argued that the retention of phosphate was more likely to be due to adsorption than to precipitation as the reaction was found to follow the Freundlich adsorption isotherm. Also, they found that there was no precipitation of phosphate by a soil extract that would have contained any soluble compounds capable of precipitating the phosphate, and they also assumed that the concentration of acid they employed would prevent the precipitation of insoluble phosphates. Their argument has been criticized by Fisher (42) and Comber (21). Fisher pointed out that compliance with the Freundlich equation is not restricted to adsorption reactions, whilst Comber showed that the strengths of acid used by Russel and Prescott were not sufficient to prevent the precipitation of phosphate. Murphy (98) objected to the precipitation theory on the grounds that only under conditions of extreme acidity is sufficient iron or aluminium present in the soil solution to cause rapid precipitation, though for this criticism to be valid it would be necessary to show that the soil solution cannot be rapidly renewed by dissolution of iron or aluminium from the solid phase.

It has already been pointed out that numerous workers have shown that iron and aluminium hydroxides and hydrous oxides can sorb phosphate. It has therefore been postulated that there is an exchange reaction between phosphate ions (mainly $H_2PO'_4$ HPO''_4) and the hydroxyl ions present in these compounds (56, 86, 87, 115). Kelly and Midgley (66) found an increase in pH value when ferric hydroxide and a phosphate solution at the same pH value were mixed. Ford (44) and Kelly and Midgley (66) showed that only iron oxide that is hydrated will retain phosphate and the substance loses this property if it is strongly heated. Heck (56) believed that in Hawaiian soils, which are known to fix phosphate very strongly, a basic ferric phosphate is formed, i.e., not all the hydroxyl groups are replaced. Swenson, Cole, and Sieling (139) have claimed that not more than one of the hydroxyl ions of iron and aluminium hydroxides can be replaced.

Mattson and Karlsson (89) and Karlsson and Mattson (65) studied the effect of salts on the retention of phosphate by aluminum hydroxide and concluded that phosphate ions may be ' saloid-bound ' or ' colloid-bound ', that is, be ' gegen-ionen ' or be chemo-sorbed. The phosphate is predominantly ' saloid-bound ' when the precipitate has a positive charge, as it has at low pH values. Both Mattson (83) and Schofield (130) attributed the retention of chloride and sulphate ions by clay at low pH values to the presence of free hydrous iron and aluminium oxides, especially the former.

Although there is good evidence that either iron or aluminium, or both, can react with phosphate under the conditions that exist in soil, it cannot be stated with certainty whether these ions come from the clay minerals or from the free hydrous oxides. There seems no reason why they should not come from both. Further, there is uncertainty on

the mechanism of the reaction. The distinction between precipitation on the one hand, and adsorption with the formation of chemical bonds (chemo-sorption) on the other, is a fine one, and will be difficult to resolve.

2. Calcium and magnesium compounds.

Both Way (154) and Voelcker (147) supposed that an insoluble calcium phosphate is formed when a soluble phosphate is mixed with soil containing calcium carbonate. This insoluble phosphate was assumed to be either dicalcium phosphate or tricalcium phosphate (48, 62, 129, 137), though tricalcium phosphate was thought to be produced in all soils containing more than a trace of calcium carbonate. Bassett (6), however, after a phase-rule study of the system CaO-P_2O_5-H_2O concluded that a more basic compound such as hydroxy-apatite would be formed in neutral and calcareous soils. McGeorge and Breazeale (75) later postulated the formation of carbonate-apatite in soils containing a high percentage of calcium carbonate.

Dean (28) fractionated the phosphorus contained in the slightly calcareous soil at Rothamsted and concluded that the phosphorous which had been applied as superphosphate had been retained as tricalcium phosphate or apatite. Direct evidence for the formation of a fluorine-containing apatite on this soil was later obtained by Nagelschmidt and Nixon (101) from examination of the chalk fragments by an X-ray diffraction technique and chemical analysis. This confirmed an earlier suggestion by MacIntire and Hatcher (80) that fluorapatite is formed in calcareous soils.

There is also evidence that phosphate ions can be retained through exchangeable calcium. Naftel (99) thought that this type of adsorption could take place up to about pH 6.5, but that at higher pH values tricalcium phosphate or apatite is precipitated. Other workers have postulated that exchangeable calcium can retain phosphate at pH values as low as 4.0 (2, 5, 126) or below (111). Phosphate is not precipitated from solution by Ca^{++} ions at pH values lower than about 5.0 (9, 46). Boischot, Coppenet, and Hebert (11) have recently put forward the suggestion that in calcareous soils the initial reaction is an adsorption on to the surface of calcium carbonate particles rather than to precipitation of an insoluble phosphate.

Perkins (111) found that up to pH 4.5, Mg^{++} ions that had been added to 100-mesh koalin were about as effective as an equivalent amount of Ca^{++} ions in precipitating phosphate, but at higher pH values they were far less effective. He concluded that precipitation of phosphate by magnesium is not likely to be of importance in ordinary agricultural soils. Not only is the final product important, but it is also important to know the rate at which the various forms of calcium phosphate are formed. Mac Intire and his co-workers (77, 78, 79) showed that dicalcium phosphate when mixed with calcium carbonate and distilled water and kept under laboratory conditions undergoes only slow transformation to tricalcium phosphate. Thirty per cent. of the dicalcium phosphate was converted to the triphosphate in the first week, but after 12 months 40 per cent. of the dicalcium phosphate remained unchanged. They suggested (80) that the dicalcium phosphate probably persists in moderately limed soils for a considerable period. In most calcareous soils the calcium carbonate : calcium phosphate ratio is much wider than they employed, and the rate of transformation might therefore be expected to be more rapid.

The size of the apatite particles that are formed is not known, but MacIntire and Hatcher (80) suggest that compared with finely ground rock phosphate they are of ' infinitesimal fineness '. This fineness of division is one of the factors that determines the availability of the apatite to plants.

3. Compounds with clay minerals.

Montmorillonite. Scarseth (126) working with low-iron bentonite that had been electrodialysed found that the greatest sorption of phosphate by the Na-clay was at about pH 6.5. He thought that there was an exchange between PO''_4' and 3OH' groups which dissociated from aluminium ions present at the surface of the aluminosilicate. Murphy (98) found that bentonite sorbed only half as much phosphate as did kaolinite, but he did not report the relative fineness of the two minerals. Similarly, Stout (138) reported a sorption at pH 7 of 11 milli-equivalents of phosphate per 100 gm. bentonite, whereas with ball-milled kaolinite, under similar conditions 172 milli-equivalents of phosphate were sorbed. Maximum sorption with the bentonite occurred at pH 6.

Differing from this work is that of Black (10), Coleman (18, 19), Perkins and King (108) and Perkins (110), who have shown that sorption of phosphate by montmorillonite can be at least as great as by kaolinite if minerals of similar fineness of grinding are used. Black (10) found the greatest retention by bentonite ($< 2/\mu$) at pH 5-6.

Kaolinite. Both Murphy (98) and Stout (138) studied phosphate sorption by the mineral kaolinite after it had been ball-milled. They found that sorption was high and that it increased as the pH value decreased to 3.0, the lowest value investigated. Black (10) showed that ball-milled kaolinite sorbed many times more phosphate than coarse ($< 2\mu$) kaolinite, but thought that the difference was due to the kaolinite crystals having been ' split and disorganized ' during ball-milling. He found one maximum in the pH-phosphate sorption curve at pH 3.5-4.0 which he attributed to the replacement of the hydroxyl ions of the lattice layers of the kaolinite. With the coarse kaolinite there was another maximum at pH 6-7 which he thought was due to the formation of aluminium phosphate on the surface of hydrous aluminium oxides.

Cooke (22), Midgley (95), and Raychaudhuri and Mukherijee (118) reported that unground kaolinite sorbs little phosphate. On the other hand, Perkins (112), using kaolinite that had been ground to pass a 100-mesh sieve, found that almost 40 per cent. of the phosphate that had been supplied at the rate of 0.355 gm. H_3PO_4 per 100 gm. clay was retained in a few hours' shaking.

It is doubtful whether the experiments using ball-milled kaolinite give results at all analogous with those of soil clay because there is evidence that prolonged ball-milling induces changes in the crystalline structure of kaolinite. Sieling (133) found that the constituent of ball-milled kaolinite that was active in phosphate sorption could be extracted by 0.1 normal hydrochloric acid or 0.1 molar tartaric acid and believed it to be a form of hydrous alumina such as y-Al00H. Laws and Page (69) adduced evidence for the formation of a new permutite-like mineral when kaolinite is ball-milled for a long period. Perkins (112) has also given evidence that grinding causes a disruption of the kaolinite lattice that was manifested by a release of Al_2O_3, and water.

Stout (138) and Black (10) have reported that halloysite, which has a crystalline structure similar to that of kaolinite, can sorb a large amount of phosphate. Stout showed that halloysite sorbed slightly more phosphate than kaolinite over the pH range 3-10 and found greatest phosphate sorption by both minerals at pH 3, the values being 1,290 and 1,170 m.e. phosphate per 100 gm. mineral, respectively. Each mineral had been ball-milled. Black (10) reported that the maximum sorption by 60-mesh halloysite was at pH 4-5 from a solution of 1 p.p.m. phosphorus and at Hp 3.1 from a solution of 100 p.p.m. phosphorus.

Mica. Black (10) reported that a sample of illite which contained free iron oxides sorbed up to 10 per cent. of the phosphate in 48 hours from a solution of 100 p.p.m. phosphorus. The maximum from a solution of 1 p.p.m. phosphorus was at pH 5-6, and from a solution of 100 p.p.m. phosphorus at pH 3.

Perkins and King (107, 108) found that the micas muscovite, biotite, and margarite sorb large amounts of phosphate, which they attributed to the replacement of lattice silicon by aluminium.

There seems to have been no study made of the phosphate-retaining properties of the hydrous micas.

Mechanism of the reaction with clay minerals. There are two types of reaction by which phosphate ions might be retained by the clay minerals: by the formation of chemical bonds with lattice ions, and by adsorption as gegen ions.

Iron and aluminium are the only lattice ions that are likely to undergo a reaction with phosphate ions. The phosphate ions may be retained by an exchange reaction with the hydroxyl ions that are normally linked with the iron and aluminium ions. Alternatively the iron and aluminium may acquire a positive charge by the transfer of a proton from an H_3O^+ ion to an oxygen, as has been suggested by Schofield (130) for hydrous iron oxide. The former suggestion has been made by a number of workers (10, 29, 86, 115, 117, 126, 138, 142). The most direct evidence to support this postulate was presented by Stout (138). He showed that after being phosphated, the minerals kaolinite and halloysite contained fewer hydroxyl ions, for they lost less water on heating. It must, however, be borne in mind that Stout used ball-milled minerals which might have contained degradation products (v. supra).

Perkins and King (107) compared the retention of phosphate by the minerals pyrophyllite $[Si_4O_{10}Al_2(OH)_2]$ and talc $[Si_4O_{10}Mg_3(OH)_2]$ muscovite $[KAlSi_3O_{10}Al_2(OH)_2]$ and phlogophite $[KAlSi_3O_{10}Mg_3(OH)_2]$. They claimed that the pH values at which they found greatest precipitation were those that would be expected by a reaction of the metal to which the hydroxyl ions were attached. This is not clearly revealed by their published results. Thus there is some evidence, though not conclusive, that phosphate ions can replace the hydroxyl ions which are attached to the lattice ions of the clay minerals.

A different theory has been put forward by Low and Black (74). They showed that the addition of increasing amounts of phosphate to a sample of kaolinite at pH 4.5-4.7 brought increasing amounts of silica into solution. They took this as evidence for the disintegration of the surface layers of the kaolinite with the formation of insoluble aluminium phosphate and the release of silica. According to Mattson (87, 88) and Toth (142), silicate ions from artificial aluminium silicate and from some clays can be replaced by phosphate ions.

It is well established that the phosphate ions which are retained by clay particles can be replaced by other anions, at least partially. The order of replacing power of other anions depends not so much on their valency, as might be expected from the Hardy-Schulze valency rule, as on their chemical nature. Thus, it has been shown that citrate, tartrate, oxalate, arsenate, and fluoride have strong replacing properties whereas sulphate, thiocyanate, acetate, chloride, and nitrate have only weak replacing properties (29, 31, 32, 67, 123, 131). Swenson and his co-workers (139) have pointed out that the anions which are most effective in replacing phosphate can themselves form complexes with iron and aluminium.

There is no satisfactory evidence that the clay minerals have amphoteric properties and can therefore adsorb phosphate ions as gegen ions. Mattson (83) showed that if clay particles have a low $SiO_2/(Fe_2O_3 + Al_2O_3)$ ratio they become positively charged at low pH values. The retention of chloride and sulphate ions increased as the positive charge increased, though there was a small retention of both ions when the particles had a small negative charge. Schofield (130) has also shown that at low pH values chloride ions can be retained by clay particles even though they have a net negative charge. Both these

workers have attributed this manifestation of the amphoteric properties of the clay to the free iron oxide and not to the clay minerals.

The replacement of a small amount of the adsorbed phosphate by chloride ions has been attributed to a replacement of gegen ions (159). This phosphate is termed ' saloid-bound ' according to the terminology of Mattson and Karlsson (89). There is, however, no evidence to decide whether the clay minerals or the free hydrous iron and aluminium oxides are responsible for this type of adsorption.

4. Compounds with other inorganic soil constitutents.

Quartz. It has been found that a silica hydrogel can retain some of the phosphate from a solution of monocalcium phosphate (51, 134). This was explained by Ghosh and Bhattacharyya (51) as being due to adsorption of phosphate through the calcium ions which are held by the silica gel. Perkins and King (109) and Perkins (110) showed that the retention of phosphate by finely ground quartz is very small, but in another experiment (108) they found that ball-milled quartz sorbed a considerable amount of phosphate. It is possible that this sample of quartz had been contaminated in the ball-mill.

Manganese. Teakle (141) reported that phosphate was least soluble in the presence of manganese chloride at about pH 6.3. He suggests that $Mn_3(PO_4)_2$ might form in soil at this and slightly lower pH values.

Titanium. According to Pugh (114) titanium chloride can precipitate phosphate at low pH values, but the precipitate hydrolyses at pH values above about 6. Perkins and King (109) found that 100-mesh rutile sorbed up to 0.29 gm. H_3PO_4 per 100 gm. The greatest sorption was in the pH range 3.5-5.0.

5. Compounds with organic matter.

The retention of phosphate by the non-living organic matter in soil is usually believed to be small (13, 113). Doughty gave evidence that such retention as there is, is due to a reaction of the phosphate with Fe^{+++}, Al^{+++}, and Ca^{++} ions which are associated with the organic matter (36, 37). Chaminade reported that humus forms a complex with phosphate ions which is not readily precipitated by Ca^{++} ions, even at high pH values (16). Other workers have shown that the humate ion can replace the phosphate ions that are adsorbed by clay minerals and by artificial alumino-silicates (85).

The part played by soil micro-organisms in retaining phosphate has never been thoroughly investigated. Lockett (73) has referred to some of the early literature. Pierre, in 1948, in a valuable review, suggested that micro-organisms may immobilize a large amount of phosphate when a source of nitrogen and energy is available (113). A year earlier Taylor (140) had published the results of some preliminary experiments which led him to the same conclusion. He found that the sorption of phosphate by a garden soil was substantially increased by the addition of peptone, urea, and blood meal. Sterilization of the soil by heat and by certain chemicals prevented this increase, but did not reduce the amount of phosphate retained when no organic supplements had been given. The author therefore concluded that inorganic phosphate is unlikely to be metabolized by micro-organisms unless phosphate is their limiting growth factor in the soil. At the same time, addition of substances which stimulate the growth of micro-organisms leads to an absorption by the micro-organisms which may be appreciable. In Finland, Kaila has recently shown that the carbon/organic phosphorus ratio in soils is roughly constant at 100-150, but if the ratio exceeds 200, inorganic phosphorus is liable to be biologically absorbed (63).

* * *

(For list of 162 References see the original paper pages 235-238 in the *Journal of Soil Science*, Volume 1, Number 2, January, 1950.)

PROCEEDINGS OF THE FOURTH MEETING OF THE CENTRAL BOARD OF AGRICULTURE HELD AT THE PROPAGANDA DIVISION HALL, (SEAC WAR BOX) ON NOVEMBER 14, 1949, AT 2 P.M.

Mr. D. Rhind (Director of Agriculture), presided, and the following were present:—Mr. R. Singleton Salmon; Dr. E. Phillis (Director, Rubber Research Scheme); Mr. W. P. A. Wickremasinghe M.P.; Mudaliyar N. M. Abulcassim Marakar; Mr. S. L. Bandara Dharmakirti; Mr. U. B. Dedigama; A. E. Madawala Dissawa; Mr. E. Abbeyratne (Agricultural Research Officer, Maha Illuppalama); Dr. M. F. Chandraratne (Botanist and Senior Agricultural Research Officer); Mr. H. A. Pieris (Divisional Agricultural Officer, E. D.); Dr. W. R. C. Paul (Acting Principal, School of Agriculture, Peradeniya); Mr. F. C. Cooke (Director, Coconut Research Scheme); Mr. S. C. Fernando, C.C.S. (Registrar of Co-operative Societies); Hon. Mr. H. W. Amarasuriya (Minister of Commerce and Trade); Mr. S. G. Taylor (Director of Irrigation); Mr. E. Muttukumaru; Mr. Marcus S. Rockwood; Mr. H. Abeyagoonesekera; Mr. A. Perumynar; Mr. W. M. Cumaraswamy; Mr. S. F. Amarasinghe, C.C.S. (Land Commissioner); Rev. Fr. L. W. Wickremasinghe; Senator Chas. A. M. de Silva; Sir James P. Obeyesekere; Gate Mudaliyar N. Wickremaratne; Senator Colonel T. Y. Wright; Mr. Thomas Amarasuriya; Mr. R. T. Chelliah; Major E. C. de Fonseka, M.B.E., E.D.; Mr. S. Sivapalan, M.P.; Mr. P. B. Bandaranayake; Senator C. Wijesinghe; Senator Justin Kotalawala; P. B. Bulankulama Dissawa (Parliamentary Secretary to the Ministry of Agriculture and Lands); Mr. P. B. Tennekoon; Mr. A. M. Clement Dias and Mr. H. E. S. Ranasinghe, C.C.S. (Secretary, Central Board of Agriculture).

The following visitors were also present:—Mr. G. J. P. Perera; Mr. P. G. Malkani (Acting Deputy Director, Veterinary).

Letters and telegrams regretting inability to attend the meeting were received from the following members:—Mr. S. A. I. Elapata; Conservator of Forests; Mr. R. H. Spencer Schrader; Director, Tea Research Institute; Mr. K. W. Devanayagam; Gate Mudaliyar M. S. Kariapper and Mr. A. Hensman.

I. CONFIRMATION OF THE MINUTES OF THE LAST MEETING

The Board was of opinion that the minutes were a correct record of the proceedings of the last meeting and approved its confirmation, but Gate Mudaliyar Wickremaratne protested against the confirmation of the minutes on the ground that indulgence had been granted by the Chairman to a member to speak on the minutes of a previous meeting which had been confirmed, with the result that a wrong construction had been placed on facts by the speaker in referring to history and the work done by the Sinhalese Kings.

The Chairman pointed out to Gate Mudaliyar Wickremaratne that the fact that Mr. Spencer Schrader was allowed to speak did not invalidate the minutes. He was allowed to speak and a record of what he said was made in the minutes. If the Gate Mudaliyar objects to what the speaker had said, he could do so, but the Gate Mudaliyar could not object to a record of what he said being made in the minutes. The Chairman added that if the Gate Mudaliyar took objection to what Mr. Spencer Schrader had stated, he could move a separate resolution at the next meeting and he hoped that Mr. Schrader would be present to hear his resolution. The minutes were then confirmed as correct.

II. A TALK ON PADDY BUG CONTROL BY DR. B. A. BAPTIST, ENTOMOLOGIST OF THE DEPARTMENT OF AGRICULTURE

1. Dr. Baptist—" The paddy bug commonly called the paddy fly is an insect which sucks the developing earheads of paddy reducing the grains to empty husks and this is a major cause or a major factor leading to the formation of chaff in the final crop obtained. It is the most important agricultural pest in this country and is one of the major factors contributing to the low average yield of 15 bushels per acre of Ceylon paddy.

2. It is a plant sucking bug about 3/5ths of an inch in size, brownish in colour and having a strong, pungent odour, and quite active when disturbed. It generally lays its dark brown eggs on leaves of plants and these hatch out into young greenish bugs which resemble the parent except in size, colour and the absence of wings. They reach the winged adult stage within a month. Both young and adult bugs feed by sucking young, developing grains in the milky stage before the grain hardens, thus reducing the grain to a shrivelled remnant. In the absence of paddy, feeding and, to a smaller extent, breeding can take place on a restricted scale on wild grasses and this actually occurs in the intervals between the normal paddy cultivation seasons. The adults can also subsist for long periods without any appreciable quantity of food and withhold their eggs until the paddy flowering season approaches.

3. The paddy bug dislikes very intense sunshine and desiccating wind and when the weather is very bright or very windy, the pest is generally insignificant or tends to become reduced. Conversely dull, showery weather is very favourable, both directly as well as indirectly by causing an extension of the cultivation season and intense development restricted scale on wild grasses and this actually occurs in the intervals between the normal paddy cultivation we should have the flowering during the period of bright weather which is really unfavourable for the development of the paddy bug. But under abnormal conditions when the weather is not quite bright but dull and rainy during the harvesting season, the paddy bug finds it very favourable and is very active under those conditions. Also, abnormal conditions especially badly distributed rainfall and inadequate rainfall tend to put seasonal cultivation out of order by extending the season so that in any particular area the paddy flowering is not simultaneous. This enables the paddy bug or the population of paddy bugs to be carried over from one crop to another, so that by the end of the season several generations of pests develop, thus increasing in appreciable numbers so as to cause heavy and widespread damage.

4. With regard to the controlling of these pests, it is considered generally under two aspects, prevention, and cure. With regard to prevention, the necessary requirements would be to introduce conditions that are unfavourable for multiplication of this pest. This can be brought about by modifying the cultivation or arranging it in such a way as to bring in simultaneous development of the crop. This is what is normally done in approved or recommended agricultural practices. Thus in any particular area it is recommended that a single variety be grown and the seasonal cultivation be confined to a comparatively short period, so that optimum conditions are available for the development of the crop. The other feature which can cause a very appreciable effect in prevention is the control of wild grasses or weeds which give shelter and a certain amount of food and breeding opportunity for the paddy bug. Normally when paddy is not available it is in such regions that the pest shelters until such time as the paddy is available. Well, so far as these measures can be carried out they would prevent the pest from breeding to any great extent.

5. With regard to curative methods the method of eradication that can be practised with more or less complete success is the application of insecticides. An insecticide,

Gammexane, has been found which gives a completely effective control of the pest and its use is practicable from the point of view of availability and price. Gammexane can be applied either as a dust or spray. When Gammexane is applied on the paddy bug it gives more or less 100 per cent. control and also has some residual effect for a short period of time by causing mortality of bugs that subsequently come to such areas.

6. The paddy bug is a pest on which we know practically everything from the point of view of control. There is no reason, therefore, why it should continue to be a serious economic factor. But the position at present is that it is a fairly serious economic factor and that it does cause quite an appreciable loss in the paddy produced. Actual analysis of earheads have shown that even in areas in which paddy bug had not been specially noticed on the crop anything up to 4 per cent. of the grains had been actually attacked by the pest. Where conditions are favourable and bugs actually noticed, anything from 10 per cent. to 100 per cent. of the crop was ruined depending on the promptness and efficiency with which control action was taken. It will therefore not be an overestimate to state that on an average at least 4 per cent. of the annual paddy crop is ruined by paddy bug. On this analysis at least half a million bushels of paddy is lost annually to feed the paddy bug if no control action is taken against this pest. As far as normal cultivation is concerned the Department does help with all the advice that is necessary, but the question arises as to whether having got all the advice that is necessary, the cultivator can put this into effect, making an appreciable reduction of the loss brought about by this pest. As far as one can reasonably assume a normal cultivator does not take action with regard to saving his crop from the pest unless he actually notices the pest in appreciable numbers. As I said a certain amount of loss is experienced even when the pest is not conspicuously noticed so that this amount of loss is definitely experienced. Where it is noticed the position of the cultivator is such that by the time he is able to take effective action, if he is willing to do so, a good portion of damage is already done and the most he does is, perhaps, to save a portion of the crop. Hence a very great deal of pest damage is still being experienced in spite of completely effective control measures being available.

7. It is clear that effective 100 per cent. control can be achieved, but to do so it is necessary to go beyond the stage of giving advice to the stage of actually taking action. This can be achieved only by delegating special people for this work provided with the necessary facilities for taking prompt and effective action over the entire area within their control. The main question which arises from a consideration of this pest is whether a feature like pest control can be entrusted to cultivators or whether an organization like a State Organization should take up the control of pests, though not necessarily as a free measure. Pest control is of such a nature that it is difficult for a cultivator to carry it out with complete success. Another reason which supports the maintenance of a special organization is that in the event of neglect by one or more cultivators, it is possible that the effect of that neglect will be felt not only by the cultivator concerned but by all the cultivators in the District, who may have carried out their cultivation with all the necessary precautionary measures for prevention of the pest."

At the conclusion of the lecture, the Chairman informed the house that any members desiring to ask any questions from Dr. Baptist may do so. Various questions were asked and duly answered by Dr. Baptist. The Chairman then brought these discussions to a close as there was a lengthy Agenda to cover and requested members who had any further questions to ask to refer them to Dr. Baptist, direct.

The Chairman while taking up the next item on the Agenda requested members to limit their speeches to ten minutes and suggested 10 minutes for the Mover and 5 minutes for the Seconder, in view of the large volume of work before the house.

2——J. N. A 97897 (5/50)

III. RESOLUTIONS TO BE MOVED

Gate Mudaliyar Wickremaratne prior to moving the 1st Resolution against his name which was the next item of the Agenda stated that it was impossible for him to limit his speech to 10 minutes as he had not prepared his speech to suit the limited time.

He then moved the following resolution:—

> " That the deliberations of the Sub-Committee as recorded in the Minutes now before the Board would go to show that the only way to stepping up food production—production of paddy being the staple food of the people of this country—is by setting up a special branch of the Department of Agriculture under the immediate charge of the Director of Agriculture or under a Deputy Director. Food production with at least six of the Divisional Agricultural Officers having a Senior Agricultural Officer attached to every Kachcheri manned with a number of Agricultural Instructors at least one to each D. R. O's division and a number of cultivation officers to work under each Agricultural Instructor and with Vel-Vidanes working under them with the co-operation of the Government Agents and Assistant Government Agents through the District Agricultural Committees and this Board recommends to the Hon. the Minister for Agriculture and Lands for his serious consideration the advisability of establishing such a division of the department and getting it to work at the earliest possible opportunity."

and said that Dr. Baptist's lecture had sufficiently revealed that it was no easy matter to grow paddy. Mudaliyar Wickremaratne felt that advice alone was not sufficient to improve paddy cultivation. On the other hand he said, it was not the intention of Government to penalise cultivators. Dr. Baptist's lecture had revealed the difficulties of the cultivator and Mudaliyar Wickremaratne felt that that was one point in favour of his resolution. He said that if paddy cultivation was done at the proper time, the danger of the paddy bug could be eliminated, and if the ridges were properly built and repaired the paddy bug would disappear. If the seed paddy used for the tract of land was of the same age and if blossoming and ripening took place at the same time, the destruction and damage by the paddy bug would be very little. He also added that the treatment recommended should be supervised and a closer contact between the cultivator and some supervising authority was necessary. He said that they had been talking for the last 37 years to improve paddy cultivation. In 1887 the machinery for encouragement of paddy cultivation was abolished as a result of the abolition of the paddy tax. Since that time no one had thought of paddy cultivation. He said that the previous Minister of Agriculture should be paid a tribute for having helped the cultivator by restoring tanks. If there were tanks, any amount of land could be asweddumized. People did not believe that hills could be cultivated with paddy with sufficient water and yet this was being done towards the Kadugannawa hills. If paddy cultivation was to be improved it was necessary to see that paddy cultivation was done at the proper time and that proper statistics were taken of yields. An organization should be set up with a sufficient staff to look after the paddy cultivation as was done during the times of the Sinhalese Kings and during the early British period. The Island should be divided into seven areas and each area should be under a Divisional Agricultural Officer and under him a number of Agricultural Instructors. The six divisions he suggested were (1) Jaffna (Northern Province) with 3 Senior Agricultural Instructors attached to the 3 Kachcheries, Jaffna, Mannar and Vavuniya. (2) Anuradhapura (North-Central Province) and Trincomalee District with 3 Senior Agricultural Instructors attached to the Anuradhapura, Polonnaruwa and Trincomalee Kachcheries. (3) Batticaloa—Batticaloa District and Province of Uva with 3 Senior Agricultural Instructors attached to Batticaloa, Kalmunai and Badulla Kachcheries. (4) Matara (Southern Province) with 3

Senior Agricultural Instructors at Hambantota, Matara and Galle Kachcheries. (5) Colombo (Western Province) and Ratnapura District with 3 Senior Agricultural Instructors at Colombo, Kalutara and Ratnapura Kachcheries. (6) Kurunegala (North-Western Province) and Matale District with 3 Senior Agricultural Instructors at Kurunegala, Puttalam and Matale Kachcheries. The seventh area he suggested was Peradeniya or Kandy under the Director or Deputy Director, comprising Kandy, Nuwara Eliya and Kegalle Districts with 3 Senior Agricultural Instructors at Kandy, Nuwara Eliya and Kegalle Kachcheries. He suggested 118 Agricultural Instructors, one for each D. R. O's Division and in certain cases two. 400 Cultivation Officers at an average of four for each Agricultural Instructor. He suggested that the Vel-Vidanes already functioning could be made use of and others may be elected or appointed. He believed that the Clerical Staff and the Minor Staff in existence could be made use of for the scheme with an addition of 10 for the Clerical Staff and 10 for the Minor Staff. He suggested that the Vel-Vidanes should prepare lists of paddy fields with the following particulars scrutinized by senior officers:—Name of land, name of owner, cultivator or lessee, extent of land, date of cultivation, date of sowing, date of harrowing, yield, quantity required for the cultivation requirements including seed paddy, and excess available for sale. The Vel-Vidane should see that the fields are well prepared and cultivated at the proper date and this should be supervised by the Senior Officers. The Cultivation Officers should visit each of those areas at the time of cultivation, sowing and a month after sowing to adjust the growing plants, filling vacancies, &c. He also suggested that the A.I. should visit the fields at the time when crops are ripening in order to gather the information necessary for a forecast of the crop. The Co-operative Societies organised for equitable areas should supply the necessary raw materials and implements and buy excess paddy and store the same in godowns or bissas built for the purpose. He emphasised that the cost of this whole scheme would be less than 8 lakhs of rupees and added that by the scheme he suggested, even if 5 bushels of extra paddy per acre were realised at the beginning, which he hoped could be raised to 20 bushels in 3 years, the country would be benefited to the extent of 2,000,000 bushels of paddy per year which would save a large amount of money going out of this country. He calculated the additional income by the anticipated increase in production to be about Rs. 16,000,000. He emphatically stated that if there was no reorganization on the lines he suggested it would take another 50 years to achieve any improvement in the situation. Commenting on the work of the cultivator, Mudaliyar Wickremaratne said that the paddy cultivator had to labour from 6 in the morning till 6 in the evening and at the end of such laborious work he had to be satisfied with 15 bushels of paddy, whereas there were labour organizations to look after the incomes of labourers engaged in other work. He said he was not urging that the paddy cultivator should be given anything free but what he meant was that it was necessary to have a cultivation staff to supervise their work, and a co-operative organization to supply their requirements. He emphasised that merely extending the areas of cultivation will never suit this country. He said he had been told by the Mudaliyar from Mannar that fields which were yielding 15 bushels were increased to 40, but he inquired how many people could do that without any help from Government. Commenting on the difficulty of getting staff, he said that in 33 years if the Department could not produce 100 Agricultural Instructors, there was no use in such a Department. In conclusion Mudaliyar Wickremaratne hoped that members would support his resolution and emphasised that his scheme would not cost millions to Government but the actual extra yield expected would give a bigger income to Government than the expenditure.

Mr. A Perumynar in seconding the resolution proposed by Gate Mudaliyar Wickremaratne said that the object of the resolution was to set up an organization whereby the yield per acre could be stepped up thus increasing the food supply. In support of this statement

he referred to an earlier remark by the Minister that the food supply can be increased either by extending the area of production or by increasing the yield per acre. As regards extending the area under cultivation, he believed that the Land Commissioner's Department, the Land Development Department and the Revenue Officers were taking steps towards alienating more Crown Land wherever such land is suitable for paddy cultivation. He also believed that the Village Works Sub-Divisions were taking steps to create a greater stimulus in improving and restoring as many tanks as possible so that the maximum acreage might be brought under irrigation. He said that that was an aspect of extensive food production, but the fact that more land was brought under cultivation did not appreciably increase the yield per acre. He believed that Mudaliyar Wickremaratne's intention was that extensive food production would not go far unless steps were taken to increase yields per acre, and this could not be achieved unless the necessary staff were provided. He said that the Department has farms where improved methods of cultivation are being carried out, but some organization should be set up to educate the cultivator in those improved methods. He also added that to achieve this purpose there should be a 10 year or a 20 year target within which period cultivators could be induced to adopt the improved methods of cultivation. He felt that it was a fair request that with the help of the very valuable research and experiments carried out by the Department, a separate organization should be set up whereby the cultivators in this country could be taught improved methods of cultivation by demonstrations, &c., so that ultimately they could expect improved yields and that kind of increase in yield would meet the economic conditions of the villager and will reduce their dependence on Government or Co-operative Sales Societies for issue of free bone-meal manure and free issues of seed paddy. In his concluding remarks too he requested the Director to have a 10 or 20 year target. He also added that the Department could help in the field in addition to its research and experiments.

At this stage the Chairman expressed his views on the resolution.

Chairman—" I rather think that at this point I should interpose to give you some idea of what we are trying to do in my Department now. First of all the set up proposed in this resolution is really a duplication of the Department as it exists today on the agricultural side. We have at the moment 9 Agricultural Divisions each under a Divisional Agricultural Officer. Under that officer are a number of Agricultural Instructors of whom we have 211 on the estimates. I think there are about 11 or 12 posts unfilled. We have approximately 200 Agricultural Instructors in the Department altogether. A few of these are under training overseas and the number available is about 180 or 190. The work of the Deputy Director and myself is concerned very largely with food production and I am forced to wonder what would be left to the Department that exists today if another Department were set up on top of it. We are trying as far as possible to avoid wasting time on sidelines which do not lead towards food production or to a reduction in the imports of our major plant products, such as cotton. I feel therefore that this resolution is really asking either for an enormous enlargement of the existing Department or to set up another Department on the top of it or alongside it and my personal view is that it is scarcely necessary because the work which has been urged in this resolution today is being done at the present moment. It has been suggested by the seconder that there should be a target figure of some average yield in 10 or 20 years. I am personally looking nearer than that and looking for a target somewhere in 3 years."

He added that what the Department was trying to do was to demonstrate by very simple methods to the villager on his own fields. He said that these methods have been summarised and the results of the first set of demonstrations, something over 500 plots, is being published in the *Tropical Agriculturist*. The average yield of the untreated plots was about 24 bushels and the average yield of the treated plots was about

45 bushels. That was an increase of about 100 per cent. The methods that the Department was demonstrating were all practical methods which all farmers could adopt. If the Department could induce the people to adopt those methods, they could expect a very large increase in the overall paddy yields and the output to the cultivator would be very much more than the additional expense and the additional labour involved. In conclusion he said he would lay open the subject for general discussion.

Senator Justin Kotalawala commenting on the resolution said that in his area, towards Homagama, the villagers complain that no Agricultural Department Officer had ever visited their fields and given any assistance in the cultivation. He said some Government officers were in the habit of submitting reports that a number of areas were visited even when they do not visit such areas, so that on looking at the reports the Director had cause to believe that everything was very satisfactory, whereas in actual fact nothing has been done to the villager and life goes on as it was. Therefore he agreed with the views of Mudaliyar Wickremaratne and believed that a separate Board to go into the aspect of cultivation, like the Gal Oya Board, would do a lot of good.

Mr. W. M. Cumaraswamy while agreeing with the views expressed by the Director, suggested that a special scheme be drawn up under the circumstances so that an intensive campaign may be carried on by Government. On the other hand he felt that Government might turn down the suggestion saying that paddy is not cultivated right round the year and as it is cultivated only during 3 or 5 months of the year a special branch was not necessary. He concluded expressing his view that an intensive scheme of work to help the paddy cultivators was necessary so that with the assistance given, better yields might be expected.

The Chairman said that he had tried to visit as many of those village demonstration plots as possible but there were over a thousand of them scattered all over the Island and it was not possible for him to visit all of them. Those areas he did visit were definitely giving very high yields. He wished to know from Mr. H. A. Pieris, D.A.O., E. D., as to what was happening in his Division.

Mr. H. A. Pieris said that during the last Yala season he had got the Vel-Vidanes to go into the scheme and he had brought in about 500 acres under improved cultivation. In the Hakmana area a large number of plots had been brought under improved cultivation. During one season they had managed to bring under improved cultivation about 500 acres with a fair degree of success. Certain plots suffered from lack of water while certain others suffered from too much water. He had got a batch of women demonstrators for transplanting from Kandy and hoped to extend the area to about 1,000 acres. In the Ambalantota and Hambantota areas he had got the assistance of about 10 or 12 Food Production Officers. He said the Agricultural Instructor of the area had himself laid down about 500 demonstration plots and he had adopted a method of getting women demonstrators to go from area to area. He hoped to get about 300 or 400 acres transplanted in that area. In Matara and Hambantota alone he expected to transplant about 1,000 acres. He had also arranged a number of competitions for improved methods of cultivation among villagers. By methods of demonstration and competitions arranged, they had tried to get cultivators to fertilize their paddy tracts with cattle manure. They had also given out over 1,000 bushels of pure seed paddy to cultivators.

Mr. P. B. Tennekoon said he was in agreement with the Chairman that the duplication of the Department was not going to carry them anywhere. He said that their problem No. 1 was lack of man-power. To explain that more in detail he quoted that the Anuradhapura area comprised 4,000 sq. miles and the population was 120,000. There were 20,000 cultivators for 92,000 acres to be cultivated within the Maha Season. Therefore he could not see how a special branch of the Department was going to help them, but said

he was unable to make an alternative suggestion. The problem No. 2 was that they required as much as 30,000 sticks to fence 100 acres of paddy fields. He asked whether the members could imagine how much of time and labour would be wasted on cutting these sticks alone. He reiterated that an additional Department was not going to help the cultivator either to get fence sticks or to fence their fields. He however hoped that the Land Commissioner would be able to give them a more plentiful supply of barbed wire. He said that they had to pay as much as Rs. 55 for a cwt. of barbed wire and if it were taken on loan they had to replace it in two instalments. The problem No. 3 he said was to watch at night. As much as 250,000 bushels of paddy was lost annually due to damage by cattle and wild animals. He also emphasised that a survey of some of the modern problems had revealed that the present day Goiya was degenerating. They do not even look after their plough animals. They catch the animals from the jungle and once the work is over they are again let loose into the jungle. He however did not think that the present day boys who passed out of school would do any better. He believed that Co-operative Sales Societies which are fairly well financed by Government should be able to solve this problem by establishing plough buffalo stations for small units. As regards the increasing of officers to do this work, he said at present there were Divisional Revenue Officers, Agricultural Officers, Agricultural Instructors, Food Production Officers, Co-operative Inspectors, several Village Cultivation Officers, several Administrative Secretaries, Colonization Officers, several Village Headmen, and several hundred Vel-Vidanes, who were all expected to get the villager to produce. He stressed that if the Central Board was going to recommend to Government to spend any money on employing persons, he would suggest that the lot of the Vel-Vidane be improved. He is the man who gets the job done, he should be paid a better wage and the Agricultural Instructor should teach him better methods of stepping up food production. He emphasised that those were their difficulties and he could not see how a special branch was going to help them. He did not see how a Senior Agricultural Instructor, or a Divisional Agricultural Officer or a Senior Research Officer were going to help them out of those difficulties. That very morning he had found it impossible to get 10 men to get into the field and plough for a wage of Rs. 2.50. In conclusion he reiterated the fact that creating a special branch of the Department would not help them to any extent.

Hon. Mr. H. W. Amarasuriya, Minister of Commerce & Trade, speaking next said that he would propose an amendment which would work out a happy compromise because the Director of Agriculture and Chairman of the Board and the members of the Board of Agriculture had one common object in view, namely, stepping up food production. Perhaps what Mudaliyar Wickremaratne had in mind when he proposed that resolution was not so much a new branch, but he believed it was a re-organization or a re-orientation of the Agricultural Department and the appointment of a special sub-committee to examine the set up of the Department dealing with the paddy aspect of agricultural activity. Perhaps the mover could achieve his object if something was done on the recommendations of that Special Committee. He therefore suggested that a Special Committee of the Board of Agriculture be appointed with members of the Agricultural Department co-opted to it, so that they could examine the present set up of the Department dealing with the present aspect of paddy cultivation. He explained that the Special Committee could make specific proposals with regard to insufficiency of staff or any other improvements, and those proposals could be submitted to the Minister. He said that what was really wrong was lack of co-ordination. He said it was true there was an Agricultural Department, there was an Irrigation Department, a Co-operative Department and several other Departments which are costing the Government a lot of money, but the results produced by the various Departments were not high in the estimation of the public of this country. He also requested that the Chairman as Head of the Department should have confidence in the Board and that

they were out to help as much as possible. He suggested that the Special Sub-Committee proposed by him should have the Director as its Chairman and that Experts of the Department should also be co-opted to it.

Mr. Marcus Rockwood seconded the amendment moved by Hon. Mr. H. W. Amarasuriya.

Mr. Clement Dias said that in most areas although there were Agricultural Officers, the villagers did not know much about them. He believed there was something wrong somewhere. In the Western and Southern Provinces fields were very well cultivated, but there was no proper seed paddy and no manure. Sometime back he had suggested that compost manure be obtained from U. Cs. and Municipalities and supplied to the cultivator at cost price. There was another suggestion sometime back that there should be a Deputy Director for Paddy Cultivation, but these suggestions were not taken any notice of. About 10 years ago he had suggested there should be a Paddy Advisory Committee and that too was turned down. He believed that if the amended resolution was taken up it would do a lot of good to the paddy industry.

Mr. S. C. Fernando, Registrar of Co-operative Societies suggested the usefulness of appointing a Headquarters Officer as was done in his Department for the special purpose of organising and supervising Co-operative Agricultural Production and Sales Societies. That officer directed his work from the Head Office and was very helpful in addition to the Provincial Registrars who were in charge of each Province. That system had worked well in his Department and in one year they had registered as many as 200 Societies. On the same lines he suggested that there should be a Headquarters Officer working directly under the Director who should be able to give advice when any question arises. He concluded saying that this was a suggestion made in the light of the experience gained in his own Department.

Senator Justin Kotalawala inquired whether it would be practicable to have a Conference of Vel-Vidanes of Districts at which the Agricultural Department officers should display improved methods of cultivation and give instructions. He also suggested that the Department should concentrate their activities area by area.

The Chairman said that it was not quite practicable to confine the activities of the Department to one particular area. They had to go wherever paddy was grown and to teach improved methods of cultivation. The general trend of the discussion that day appeared to him to point to two things. One was that members felt there should be more supervision and a general gingering up of the subordinate staff. The other seemed to indicate that insufficient information had been placed before the Board concerning what was being attempted by the Department. Certain suggestions had been made that day which they were already trying to carry out. It was quite obvious to him that members had not enough information before them. With regard to the first trend he agreed there should be more supervision. He said that before them were two resolutions, the original resolution of Gate Mudaliyar Wickremaratne which had been seconded and also an amendment proposed by the Hon. Minister of Commerce and Trade which has also been seconded, which moves that a Special Committee should be appointed with the Director as Chairman and members of the Department to be co-opted who should submit a report to be forwarded to the Minister.

Bulankulame Dissawa, Parliamentary Secretary to the Ministry of Agriculture speaking next, said he really could not see the purpose of that resolution, and what the co-ordinating body suggested was. Every district had its own peculiar problems and today each district had a co-ordinating body, a District Agricultural Committee. He did not see any purpose in that discussion why a new Department should be set up and why a new Committee

should be set up. It was for the Department to ginger up those institutions and get the work done. In a District Agricultural Committee there were men who were interested and people who had vested interests. It was for that Committee to discuss ways and means of solving those problems. Further than that, to his mind, a Special Committee to be appointed to discuss those problems of particular areas meant a duplication which was absolutely unnecessary. A co-ordinating body, to his mind, was absolutely unnecessary. He only wanted the Department to get its officers to get on to a real job of work. He reiterated the immense work those Agricultural Committees could do by discussing the problems common to each district and suggesting ways and means of overcoming those difficulties. That was the co-ordinating body and if the District Agricultural Committees were active enough, he did not see any purpose in appointing another Special Committee as suggested in the resolution. He was sorry to state that some of the members of the Board did not even know that District Agricultural Committees exist. He emphasised that the main object was to get the work done through the Department and its officers and that those long speeches and criticism of officers was unnecessary.

Hon. Mr. H. W. Amarasuriya, Minister of Commerce and Trade, said he was not suggesting another co-ordinating body. He only suggested that a Special Sub-Committee or a Special Committee be appointed with the Director as Chairman with members of the Department co-opted to it to go into this matter and see if any improvements could be effected. It was useful to appoint such a Committee to go into this matter instead of saying " Let's get the job of work done ", because all were dissatisfied and felt that something more could be done, and he hoped the Board would accept such a suggestion. At this stage the Chairman had to intervene and requested the members to treat that discussion as closed as they were getting a bit away from the original resolution.

At this point Gate Mudaliyar Wickremaratne protested that his resolution had not been understood by the Parliamentary Secretary to the Ministry of Agriculture. He had no intention of criticising the Department or its officers. He was sorry to state that the Parliamentary Secretary to the Ministry of Agriculture did not know his own province.

At this stage Bulankulame Dissawe inquired from the speaker whether it was philippic or diatribe and challenged the speaker that he was prepared to answer any question relating to his province.

Gate Mudaliyar Wickremaratne inquired from the Chair what the Dissawa wanted and what he meant.

The Chairman intervened again and the motion as amended by Hon. Mr. H. W. Amarasuriya was put to the house.

19 were in favour and 6 against, and the motion was carried.

Gate Mudaliyar Wickremaratne then withdrew his original resolution in favour of the amended resolution by Hon. Mr. H. W. Amarasuriya.

The following Special Committee was appointed with the Director as Chairman and members of the Department to be co-opted at the discretion of the Chairman:—

Mr. D. Rhind, Director, Chairman.
Mr. Clement Dias.
Gate Mudaliyar N. Wickremaratne.
Senator C. Wijesinghe.
Mr. Thomas Amarasuriya, Chairman, L. C. P. A.
Rev. Fr. L. W. Wickremasinghe.
Senator Justin Kotalawala.
Mr. Marcus S. Rockwood.

The Chairman felt that this might be a duplication of the Paddy Advisory Board.

Senator Wijesinghe suggested that findings of this Committee be passed on to the Paddy Advisory Board.

It was agreed that the quorum of this Committee shall be 5.

Gate Mudaliyar Wickremaratne moved his second resolution, viz.:—

> " This Board places on record the excellent work done by the Land Commissioner since the constitution of his Department for the development of lands with a view to food production in the Island ".

He said that what prompted him to move this resolution was the enormous amount of work done by the Land Commissioner's Department during the last 20 years or so since the passing of the new Land Ordinance by the Commissioner of Lands, Mr. C. V. Brayne, the first Commissioner, and then the late Mr. C. L. Wickramasinghe, Mr. A. G. Ranasinghe and Mr. S. F. Amerasinghe, the present Commissioner, who he was pleased to see present there today. He said that after the Waste Land Ordinance was passed to separate the villagers' lands from those of the Crown as some people were buying lands irrespective of the proper ownership, but it came to pass that the villagers' land were declared Crown and the villagers lost their lands. For nearly forty years villagers were not able to buy any Crown Land. It was at a meeting of this Board the new land policy was shaped and formulated the new Ordinance and finally the Hon. Mr. Senanayake, former Minister, Agriculture and Lands, started work in this respect and adopted all village expansion schemes and Crown Lands are being given to villagers.

At this stage the Chairman inquired whether he was proposing a separate resolution.

Mudaliyar Wickremaratne replied that it was only a passing comment and not a separate resolution.

Mr. A. Perumynar seconded the resolution which was put to the house and carried.

The next item on the agenda was taken up. In the absence of Mr. Spencer Schrader in whose name the resolution appeared, Mr. Thomas Amarasuriya moved,—

> " That this Board is of opinion that in the interest of those agriculturists interested in animal husbandry, outbreaks of serious epizootics should be advertised in the press by the Government veterinary surgeon ".

Speaking about the resolution Mr. Amarasuriya said that he was not an expert on animal husbandry but he undertook to move that resolution at the request of Mr. Schrader. He believed that the idea of the resolution was to give notice of outbreaks of animal diseases in the press so that people may take sufficient precautions to safeguard their animals against the spread of such disease.

Mr. W. M. Cumaraswamy in seconding the resolution said that he was one who had lost a number of livestock through disease and suggested that not only should such diseases be given publicity in the Press, but the Department should take immediate steps to find the source of infection and take necessary safeguards against the spreading of the disease.

At this stage Mr. P. G. Malkani explained to members what was meant by " epizootics " and suggested an alternative phrase which was more appropriate. He suggested that the word " epizootics " should be replaced by " scheduled diseases " and the words " Government Veterinary Surgeon " should be replaced by the words " Government Agents ", because it was the Government Agent of a Province who really proclaimed

such diseases in the *Gazette* at present. Commenting on the seconder's suggestion that the Department should find out the source of infection, he said that that was the object in keeping Veterinary Surgeons in the Department.

The Chairman commenting on the resolution said that normally when " Scheduled Diseases " of animals were notified, people could safeguard their animals and prevent the disease spreading. He said that the present resolution was designed to warn owners of cattle and other animals that a disease was present in their neighbourhood so that they could take precautions. Regarding the notification of such diseases in the *Gazette*, he agreed that only a limited portion of the public read the *Gazette* and that it was more useful to publish information in the Press.

The mover agreed to the amendments in the resolution. The amended resolution was seconded by Senator Wijesinghe. The motion was put to the house and carried.

Item 5 on the Agenda was next taken up. Mr. F. C. Cooke, Director, Coconut Research Scheme, moved the following resolution:—

> " The Food Production (Estates) Order 1942 should be amended in so far as it relates to coconuts, in that ' coconuts ' should be included in the definition of ' foodstuffs ' (paragraph 2 (1)) ".

Speaking in support of the resolution Mr. Cooke, Director, Coconut Research Scheme, said that he was one who had no property or shares or any other interests other than a desire to see that the Coconut Industry was put on a sound footing. He said that it was perhaps hardly necessary to remind them that that Order was a war measure, designed to ensure the food supplies of this country. It was introduced at a time when coconuts were being produced considerably in excess of requirements because no shipping space was available for transporting coconut products to Europe. That certainly justified its inclusion at that time from the list of foodstuffs, cited in the order. Now conditions were entirely different although the need to produce more food still remained and would remain a serious problem. Coconuts today stood high on the list of world priorities, because coconut oil was required for the manufacture of margarine and cooking oils, and poonac was needed for the production of meat, milk, butter and cheese. The report of the Ceylon Coconut Commission as members would have read, emphasised the serious position of the world supplies of oils and fats. The market position actually appeared to have given rise in some quarters to a feeling of optimism because when products were in short supply, prices were high and the future appeared to be rosy. Were oils and fats however the only foods in short supply, there might be some justification for that feeling but unfortunately the world rice position was also serious and Ceylon itself was likely to continue to be dependent on other countries for supplies of that and other essential commodities. He also felt it was not sufficiently appreciated that the exports of coconut products from Ceylon were declining, and that unless more coconuts were produced to meet the growing needs of the rapidly increasing population of Ceylon, gradually less and less would remain to be exported, so that, inevitably, Ceylon was likely to suffer the same fate as India and cease to be an exporter of coconut products. Such a decline in exports would affect the standard of living. He did not think he should labour the argument. He asked them to simply consider whether it was not at least as important to produce more coconuts as it was to grow tomatoes, melons, pineapples and sugar-cane and other food products approved as foodstuffs under the Order. He said he would therefore pass on to consider whether in fact it was sound agricultural practice to grow foodcrops under coconuts under estate conditions of cultivation. It was of course well known that near houses, where

garbage, swill, wood ashes and excreta were deposited, it was possible to grow certain food crops in association with healthy palms. But the Order applies only to the cultivation of coconuts under estate conditions. That question could be considered in three aspects:

(*a*) The effect on the palms of growing food crops.
(*b*) The effect of shade on the food crops.
(*c*) The cost of production of the food crops.

Commenting on the effect on the palms he said that the only crop under mature coconut palms which had been systematically studied for its effect on the palms was the legume, *Centrosema pubescens*. It had been reported to him by the Soil Chemist that following the drought of 1938-39, plots of coconuts interplanted with Centrosema gave an average yield of 721 lb. of copra per acre whereas plots without that underplanted crop gave a yield of 1,185 lb. per acre. The main reason for the lower yield was because the palms had to compete with the underplanted crop for the available soil moisture. The coconut palm was also known to be a bad competitor with associated crops for supplies of available soil nutrients and the association of rubber and fruit trees, pineapples and heavy undergrowth invariably results in up-standing low-yielding palms.

(*b*) The effect of shade on the food crop.—If the palms were healthy and the ground was properly covered with palms so that the fronds interlace, the ground shade is so dense that there can be little photosynthetic activity so that the underplanted crops are unable to produce proteins, starches and sugars except on a limited scale because of the lack of light. Evidence in support was provided by manioc which had been found to be the most successful crop to grow under coconuts. This crop was grown during the war under the supervision of the Botanist and the Soil Chemist of the Coconut Research Scheme who applied a systematic programme of manuring, cultivation and weeding to the crop. The records showed that they obtained only 10 tons of manioc from 11 3/4th acres—a pathetic yield justified only by the exigencies of war. It was stated that pulses, grains and sweet potatoes were also grown but with even less success. The cultivation of this crop was being continued today, but cultivation is on normal lines, i.e., the palms were manured with N.P.K., the unoccupied land was disc-harrowed, and the food crop was only weeded. The yields might be taken as typical of what was happening on all estates where underplanted crops were being cultivated merely to comply with the Order. He quoted the following figures of manioc produced—1943, 11 acres had produced 3 3/4 tons of manioc; 1944, 1.6 acres had produced ½ ton of manioc; and in 1945 1.6 acres had produced half a ton of manioc. He said that a satisfactory harvest for manioc was considered to be about 10 tons per acre so that the ridiculous inadequacy of those crops could well be appreciated. Regarding (*c*), cost of production of the food crops, he said that while the primary object was to obtain additional food, the economics of their production was not a question to dismiss lightly since the loss that was incurred represented an added burden to the industry. It was of course quite impossible to produce manioc at a profit with a yield of only 1/3 ton per acre, particularly in view of the low price of that commodity today. Reference to the current estimates for Bandirippuwa Estate would confirm the following figures for the year 1948:—Cost of production of manioc = Rs. 185.74, income from sale of manioc = Rs. 86.83. Loss = Rs. 98.91. The cost of production shown was the labour cost only exclusive of overheads. The tubers produced were small bitter and tough and the harvest was generally so insignificant (that so he was informed), the majority of superintendents did not even trouble to collect the crop. Instead the same patch of manioc was shown year after year to the visiting food crop inspectors and thus the object of the order was defeated, because there was provision that the food crop must be harvested and consumed. He remarked that a law which could not be effectively enforced was generally considered to be bad law.

In conclusion he said that only where the soil was very fertile and there was adequate light due to patches of lightning strike or vacancies, was the cultivation of another food crop in association with coconuts worthwhile. Otherwise, he said, it was an added liability to the industry and a waste of human energy which should be better employed. It constituted too an added drain on the available soil nutrients which was a very serious matter indeed on estates where there was no regular programme of manuring, that was, on nine out of ten estates, the deterioration of which was thereby accelerated. The future of this industry and of all countries was bound up with the fundamental problem of the increased production of food to meet the growing needs of an increasing world population. The continuance of World Peace today depended largely on the increased production of food which in turn required the most efficient use of the land. It was submitted that the Order, as it applied to coconuts was only justified as a war measure and that its early amendment was necessary to the welfare of this key industry in the economy of Ceylon.

Senator Colonel T. Y. Wright in seconding the resolution said he was in agreement with the mover of that resolution, but he would have preferred it if the resolution had been worded to repeal the Order. He said that that Order was introduced as an emergency measure during the war and was brought in very hurriedly and evidently without knowledge. At that time the estates were very short of labour and at the same time they had to try and get maximum crops of tea and rubber, both of them essential crops at that time and Government would not say which had to take priority. Somehow a great amount of both money and labour was wasted and the results achieved as regards food production were very poor. The Order was discriminatory as far as estates were concerned as no other owners of land and employers of labour were called upon to produce food. A few years ago, the Central Board of Agriculture passed a resolution that it was desirable that there should be an alteration in this Order. Every District Planters' Association objected and the two Planters' Associations of the coconut districts were of the same opinion and several years ago one of the big District Planters' Associations actually asked for a repeal of the Ordinance. The Low Country Products Association unanimously passed a resolution that as the Food Production Ordinance was discriminatory and unjust its ambit should be extended to include persons obtaining incomes by means independent of the cultivation of land and the liability at present placed exclusively on those engaged in agriculture should be reduced. He read the following extract from a Sessional Paper on the Food Situation in 1944:—" At this time when the international food situation is so critical and its effect on Ceylon cannot be predicted, it is clear that every section of the community must contribute its utmost in a combined effort to lessen Ceylon's dependence upon imports of food." He inquired whether the Government had made every section of the community to contribute to that cause. If the Minister of Agriculture was there, he would ask why they had not done so. He emphasised that the Government obtains 100 million rupees from the export of tea only and many millions from coconut and rubber. Estates paid several millions more by way of Income Tax and all sorts of other taxes. In the 1944-45 Appropriation Bill an old friend of his who was the Minister of Agriculture at that time had made a rather bitter speech about Tea and Rubber Planters grousing about this Ordinance but not the coconut planters. He said that the coconut planters were not only cultivating a 100 per cent. food but they had gone up to a 190 per cent. That seemed rather funny. He stressed the fact that he was perfectly sure that tea and rubber planters did their utmost. There were 4,200 estates comprising 1,400,000 acres which came under this Ordinance in 1948 and one wonders how much food was produced and how many were inspected. He believed that a more satisfactory Ordinance could be brought in making all owners of land which is suitable for the production of food to cultivate a percentage of that land each year and if the owner did not so cultivate it, he should be either taxed or the Government should take over the land. In

1944 in one of his arguments against the Ordinance he had mentioned that coconut estates were producing food all the time, and as a matter of fact, tea estates were producing a stimulating drink which is consumed nearly all over the world and which brings in a larger revenue to the country than anything else.

Referring to a paragraph in the recently published Coconut Report he said that in early times a tax had been imposed on every coconut palm. This tax was very unpopular as it was unprecedented and particularly because it taxed an essential article of diet. As a result of this discontentment people went in to open revolt and the tax had to be abandoned. He emphasised that he fully expected this Ordinance also to meet with the same fate. In conclusion he said he was sure that the Minister's ancestors would have also joined in the revolt against that tax.

Sir James P. Obeyesekere commenting on the adverse effect this Ordinance has had on coconut estates said that according to the requirement of the Ordinance they had to produce food on at least 10 per cent. of the acreage. What he desired to explain was that the coconut tree is a surface feeder. Year after year it was noticeable that the crops were diminishing. He knew of a certain property on which the decline of the crop was noticeable on the portion allotted to food crops while the other portion gave good returns.

Mr. S. F. Amerasinghe, Land Commissioner, pointed out that the Ordinance did not necessarily require that food crops should be cultivated on the estate. Six per cent. of the acreage of the estate had to be cultivated outside or 12 per cent. of the acreage of the estate itself if the crops were interplanted or they could commute their liability.

Mr. Singleton Salmon remarked that it was really taxing the tea and coconut. It was a case of pay the Government or impoverish the soil.

Senator C. Wijesinghe endorsing the views of the mover of this resolution said that the strongest argument to include coconuts under the definition of foodstuffs in this Ordinance would be that coconuts were a food by itself and that very nearly 45 per cent. of the entire production is consumed internally. On that basis he said there was a strong case for repeal of this Ordinance. He said that the Ordinance had been hurriedly imposed because at that time we were threatened with starvation and Government was in a difficult situation as to how they could provide the people of this country with food. He said that now we have come to a stage when this Order was going to affect the permanent economy of the country. He also felt that if this tax was to be levied from the three classes of employers (tea, rubber and coconut), it should be extended to every class of employer, otherwise the Order should be withdrawn and general taxation imposed. In his concluding remarks he said that in supporting the motion he would emphasise that coconut being a food product it should be exempted from this Ordinance as in actual practice it has proved suicidal.

The motion was put to the house and carried.

The meeting terminated at 4.30 p.m.

H. E. S. Ranasinghe,
Secretary,
Central Board of Agriculture.

Peradeniya, November 29, 1949.

Coconut Research Scheme (Ceylon)

BOARD OF MANAGEMENT

MINUTES OF THE 107TH MEETING OF THE BOARD OF MANAGEMENT, COCONUT RESEARCH SCHEME, HELD AT 10 A.M. ON SATURDAY, FEBRUARY 25, 1950, IN THE NEW HOSTEL BUILDING, BANDIRIPPUWA ESTATE, LUNUWILA

Present: Mr. C. A. M. de Silva (representing the small holders); Mr. H. E. Peries, C.C.S., M.B.E. (Treasury representative); Mr. E. Muttucumaru (representing the small holders); Mr. A. N. D. A. Abeyasinghe, M.B.E. (representing the L. C. P. A.); Mr. A. Hensman (representing the Planters' Association of Ceylon); Mr. F. C. Cooke, Director, Coconut Research Scheme; Mr. S. C. Kahawita, Secretary-Accountant, C. R. S.

1. The newly built hostel, after a simple ceremony, was opened by Mr. Graham Panditteseker a, J.P., U.M., and named " Palm Court ".

A letter from the Chairman, regretting his inability, due to other engagements, to attend the meeting was tabled. In accordance with para 2 of the first schedule to the C. R. S. Ordinance (Cap. 303), on a proposal by Mr. A. Hensman, Mr. C. A. M. de Silva was unanimously voted to the chair.

Apologies for absence were received from Mr. T. Amarasuriya, Mr. Albert F. Peries, Mr. N. H. Kirthiratne, M.P., Mr. R. H. Spencer Schrader, J.P., U.M., and Mr. C. E. L. de Silva

2. MINUTES

The minutes of the previous meeting held on December 21, 1949, which had been circulated (C.P. 806) were confirmed without amendment..

3. CORRESPONDENCE

A letter from the Hon. Minister of Finance authorizing Mr. H. E. Peries, C.C.S., M. B. E., to attend the 107th meeting of the Board of Management in the absence of Mr. T. D. Perera, C.M.G., the Treasury representative, was tabled.

4. BOARD OF MANAGEMENT

(*a*) The Chairman said that Mr. G. Panditteseker a's, J.P., U.M., 18 years of uninterrupted association as the Small Holders' representative on the Board was unique, and it was the Board's duty to record the valuable service since 1932 rendered by him as a member of the Board and as Chairman of the Buildings Sub-Committee. It was seldom that he missed a Board or a Sub-Committee Meeting. It was the unanimous wish of the Board that their thanks for this long service should be recorded and a copy of this resolution sent to Mr. Panditteseker a for his information.

(*b*) The Chairman, in welcoming Mr. E. Muttucumaru as the new representative of the Small Holders, said that Mr. Muttucumaru was not new to the Board, as previously in 1946-49 he had represented the Planters' Association on the Board.

(*c*) *Sub-Committees: (i) Building Sub-Committee.*—It was decided that the present three members, Mr. A. F. Peries, Mr. A. N. D. A. Abeyasinghe, and Mr. R. H. Spencer Schrader, would be sufficient for this Committee.

Technical Assistant to the Soil Chemist.—It was reported that 10 applications to this post were received, and Mr. W. B. W. Tissera who is a science graduate has been appointed from March 1, 1950.

Price of Seednuts and Seedlings.—The Board while ratifying the following prices already agreed to by the Director and the Planting Officer (C.P. 799 para 4 A.) were of the opinion that it was not advisable for the C. R. S. at present to grant licences or approve coconut seedling nurseries.

		Rs.	
I.	Purchase price of block seednuts from estate	200	per
II.	Sale price of Grade I seedlings	900	
III.	Sale price of Grade II seedlings	500	1,000

The Estimates of the Planting Division.—The Estimates of the Planting Division which had been submitted to the Director of Agriculture and circulated to the Board were approved without amendment.

Rubber Research Scheme (Ceylon)

MINUTES OF THE NINETY-NINTH MEETING OF THE RUBBER RESEARCH BOARD HELD AT THE PLANTERS' ASSOCIATION HEADQUARTERS, COLOMBO, AT 2.30 P.M. ON FRIDAY, MARCH 24, 1950

Present: Mr. D. Rhind, O.B.E. (Director of Agriculture) in the chair; Dr. E. Phillis, Ph.D., D.Sc. (Director, R. R. S.); Mr. T. D. Perera, C.C.S. (Deputy Secretary to the Treasury); Mr. F. H. Griffith, M[illegible]; Mr. R. J. Hartley; Major M. Jayewickrema, M.P.; Mr. F. A. Obeyesekera; and Mr. J. L. D. Peiris.

An apology for absence was received from Senator C. Wijesinghe.

1. MINUTES

(*a*) *Signing.*—Draft minutes of the meeting held on January 10, 1950, which had been circulated to members, were signed by the Chairman on signification of members' assent that they were in order.

(*b*) *Matters arising from the minutes*—

1. *Experimental Committee.*—The Chairman reported that Mr. J. D. Falconer had been nominated by the P. A. of Ceylon to serve on the Experimental Committee representing the K. V.—Kegalla area. The nomination was accepted.
2. *Posts of Chemist and Agronomist.*—Agreed that the posts be advertised.

2. BOARD

The Chairman reported that Mr. Francis Amarasuriya would be away from the Island until the end of July, 1950. It was agreed that Mr. Amarasuriya be given leave of absence from meetings until July 31, 1950.

3. EXPERIMENTAL COMMITTEE

The following recommendations of the Committee were adopted:—

(*a*) That Mr. F. H. Griffith be Chairman of the Committee.

(*b*) That the present transport contractor's tender for transport during 1950, be accepted.

(*c*) That the Government holidays at Sinhalese New Year, Wesak, and Thai Pongal be granted to the staff.

4. REPORTS AND ACCOUNTS

(*a*) *Statement of Receipts and Payments for the 4th quarter, 1949, was adopted.*

(*b*) *Estate accounts for November 1949, were tabled.*

(*c*) *Investments.*—Reported that a sum of Rs. 250,000 had been invested in 3¼ per cent. Ceylon State Mortgage Bank debentures.

5. INDIAN LEAF DISEASE

Reported that the latest information from South India revealed that the disease recently reported from South India was a Thread Blight. There was therefore no cause for alarm.

6. STAFF

(*a*) *Research Assistant.*—Reported that Mr. M. S. Wijeratne, Research Assistant (Chemical Department), had resigned with effect from January 19, 1950.

(*b*) *Junior Staff.*—Changes in staff were reported.

7. LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH (CEYLON AND MALAYA)

Minutes of meetings of the Committee and the Technical Sub-Committee held on November 4, 1949, were tabled.

8. CHAIRMAN OF THE BOARD

Reported that the amending Ordinance providing for the Board's Chairman being elected by the members had received the assent of the Governor-General. The Board expressed the unanimous wish that Mr. Rhind should continue to function as Chairman and noted that he would consult the Minister of Agriculture and Lands in this connection.

9. FIELD DAY AT KEPITIGALLA

It was noted that a Field Day would be held at Kepitigalla Estate on April 1 to show the resistance of clone LCB. 870 to Oidium and to demonstrate new methods of Oidium control.

C. D. DE FONSEKA,
Secretary-Accountant.

Dartonfield,
Agalawatta, April 5, 1950.

3— J. N. A 07897 (5/50)

ANIMAL DISEASE RETURN FOR THE MONTH ENDED JANUARY 31, 1950

Province	Disease	Fresh Cases during the month	Cases up to date since Jan. 1, 1950	From Jan. 1, 1950 to Jan. 31, 1950			
				Deaths	Recoveries	Balance ill	No. shot
Western Province	Foot-and-mouth	—	—	—	—	—	—
	Rabies	—	—	—	—	—	—
	Piroplasmosis	—	—	—	—	—	—
Colombo Municipality	Foot-and-mouth	60	60	—	—	60	—
	Rabies	9	9	9	—	—	—
Quarantine Station	Anthrax (in sheep and goats)	9	9	9	—	—	—
	Foot-and-mouth	—	—	—	—	—	—
Northern Province	Foot-and-mouth	354	354	5	276	73	—
	Anthrax	—	—	—	—	—	—
	Rabies	2	2	—	—	—	2
	Black Quarter	—	—	—	—	—	—
North-Central Province	Foot-and-mouth	—	—	—	—	—	—
	Rabies	—	—	—	—	—	—
North-Western Province	Foot-and-mouth	4	4	4	—	—	—
	Rabies	—	—	—	—	—	—
Central Province	Mange (cattle)	313	313	—	160	153	—
	Rabies	—	—	—	—	—	—
	Piroplasmosis	1	1	—	1	—	—
	Foot-and-mouth	—	—	—	—	—	—
Sabaragamuwa Province	Piroplasmosis	—	—	—	—	—	—
	Foot-and-mouth	—	—	—	—	—	—
	Rabies	1	1	—	—	—	1
Uva Province	Rabies	1	1	—	—	—	1
	Black Quarter	—	—	—	—	—	—
Eastern Province	Rabies	1	1	—	—	—	1
	Black Quarter	—	—	—	—	—	—
Southern Province	Rabies	—	—	—	—	—	—

Peradeniya, April 18, 1950.

P. G. MALKANI,
Acting Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED FEBRUARY 28, 1950

Province	Disease	Fresh cases during the month	Cases up to date since Jan. 1, 1950	From Jan. 1, 1950, to Feb. 28, 1950			
				Deaths	Recoveries	Balance Ill	No. Shot
Western Province	Foot-and-mouth	3	3	—	—	3	—
Colombo Municipality	Foot-and-mouth	181	241	—	—	241	—
	Rabies	7	16	16	—	—	—
	Piroplasmosis	1	1	—	1	—	—
Quarantine Station	Anthrax (in Sheep and Goats)	10	19	19	—	—	—
Northern Province	Foot-and-mouth	135	489	7	398	84	—
	Rabies	1	3	—	—	—	3
North-Western Province	Foot-and-mouth	—	4	4	—	—	—
	Rabies	2	2	—	—	—	2
Central Province	Mange (cattle)	—	313	—	200	113	—
	Foot-and-mouth	107	107	1	19	87	—
Sabaragamuwa Province	Rabies	6	7	5	—	—	2
Uva Province	Rabies	—	1	—	—	—	1
Eastern Province	Rabies	—	1	—	—	—	1

P. G. MALKANI,
Acting Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

Peradeniya, May 3, 1950.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED MARCH 31, 1950

Province	Disease	Fresh Cases during the month	Cases up to date since Jan. 1. 1950	From Jan. 1, 1950 to March 31, 1950			
				Deaths	Recoveries	Balance ill	No. shot
Western Province ..	Foot-and-mouth	38	41	—	37	4	—
Colombo Municipality	Foot-and-mouth	153	394	—	241	153	—
	Rabies	10	26	26	—	—	—
	Piroplasmosis	2	3	3	—	—	—
	Tuberculosis	1	1	1	—	—	—
	Mange	1	1	—	—	1	—
Quarantine Station ..	Anthrax (in sheep and goats)	22	41	41	—	—	—
Northern Province	Foot-and-mouth	414	912	7	787	118	—
	Rabies	3	6	—	—	—	6
North-Western Province	Foot-and-mouth	4	8	6	—	2	—
	Rabies	2	4	1	—	—	3
Central Province	Mange (cattle)	55	368	—	267	101	—
	Foot-and-mouth	47	154	1	101	52	—
	Piroplasmosis	—	1	—	1	—	—
Sabaragamuwa Province ..	Rabies	2	9	5	—	—	4
Uva Province ..	Rabies	—	1	—	—	—	1
Eastern Province	Rabies	—	1	—	—	—	1
	Surra	69	69	69	—	—	—
Southern Province	Foot-and-mouth	12	19	—	19	—	—
	Rabies	1	1	—	—	—	1

P. G. MALKANI,
Acting Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

Peradeniya, May 17, 1950.

METEOROLOGICAL REPORT, JANUARY, 1950

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		In.		In.
Agalawatta	88·7	0·5	68·7	—1·8	—	97	—	2·02	8	— 5·26
Anuradhapura	83·4	0·1	64·9	—4·4	69	95	3·0	1·64	4	— 4·16
Badulla	75·2	—1·2	61·8	—1·9	78	94	4·6	7·02	15	— 3·30
Batticaloa	80·8	—0·8	72·6	—0·9	75	85	5·2	9·48	13	— 3·40
Colombo	87·6	+1·1	70·0	—1·8	68	90	3·8	0·82	4	— 3·14
Diyatalawa	71·7	—0·2	55·3	—2·2	76	94	5·4	3·01	13	— 3·63
Galle	83·6	—0·3	71·7	—1·3	77	93	5·0	3·61	11	— 0·27
Hakgala	—	—	—	—	—	—	—	6·34	12	— 6·09
Hambantota	84·9	—0·2	71·4	—1·2	72	88	4·3	0·61	4	— 3·39
Jaffna	83·1	+0·1	70·0	—2·1	66	90	4·0	1·11	3	— 3·30
Kandy	83·8	+0·2	65·2	—1·9	66	87	3·6	2·25	7	— 4·09
Kurunegala	86·2	—0·4	67·4	—2·4	64	90	2·9	0·84	7	— 4·27
Ratmalana	88·1	—	68·6	—	64	90	4·0	1·19	5	—
Mannar	82·7	—0·7	72·8	—1·4	70	81	3·6	2·02	4	— 1·82
Nuwara Eliya	67·8	0	43·3	—3·2	67	82	3·5	3·20	10	— 3·76
Puttalam	86·8	+1·3	67·4	—2·6	64	92	3·6	0·57	3	— 2·86
Ratnapura	90·1	+0·7	69·5	—1·6	67	93	5·3	3·02	9	— 3·24
Talawakele	73·8	—0·5	52·7	—2·7	64	74	3·1	0·82	8	— 3·05
Trincomalee	79·8	—0·8	75·5	+0·3	74	75	4·5	2·36	6	— 5·95

WEATHER SUMMARY—JANUARY, 1950

Rainfall in January was below normal over the major part of the Island. The larger deficits occurred on the north-eastern slopes of the hills and in the north-east, the highest being 13.14 inches at Illukkumbura, 12.14 inches at Ledgerwatte Estate and 10.47 inches at Kal Aar. The largest excess was 6.36 inches at Kalmunai.

Rainfall was heaviest on the north-eastern slopes of the hills, as is usual for this time of year, several stations recording totals over 20 inches. Outstanding totals were 32.66 inches at Hendon Estate, 30.69 inches at St. Martin's (Upper) Estate and 29.58 inches at St. Martin's (Lower) Estate. Rainfall was least along the west coast and in the south-western hill country, where the totals were generally less than 2 inches.

There were 15 daily falls over 5 inches in January, the highest being 10.00 inches at Sengapodai on the 18th, and 8.12 inches at Hendon Estate on the 10th.

The only appreciably wet days during the month were 7th to 10th, 26th and 27th.

Day temperatures were generally about normal, while night temperatures were appreciably below normal. The highest temperature recorded in the shade was 94.2° at Ratnapura on the 26th, while the lowest temperature for the whole Island was 31.7° at Nuwara Eliya on the 4th. The minimum temperature at Colombo was 60.0° on the 3rd, and 59.4° on the 4th (a new low record). The previous record at Colombo was 60.8° on February 15, 1949.

Humidities were of the order of 70 per cent. by day and 90 per cent. by night. Cloud amounts were above average in the south and south-east and below average elsewhere. Wind strength was mainly above normal, the prevailing direction being north-easterly.

D. T. E. Dassanayake,
Director.

METEOROLOGICAL REPORT, FEBRUARY, 1950

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		In.		In.
Agalawatta	89·9	0	70·5	—0·5	78	97	4·5	5·77	8	+ 0·28
Anuradhapura	88·3	+1·3	68·3	—1·3	66	95	5·4	2·96	7	+ 1·24
Badulla	79·3	+0·3	62·4	—0·7	71	94	4·8	5·55	9	+ 2·38
Batticaloa	83·3	+0·3	73·3	—0·5	78	93	6·2	5·89	9	+ 1·68
Colombo	87·8	+0·5	72·2	+0·1	72	93	4·8	10·60	7	+ 8·00
Diyatalawa	75·0	+0·3	57·0	+0·2	67	85	5·8	4·09	10	+ 1·72
Galle	85·2	—0·1	74·2	+0·5	74	88	6·0	1·65	9	— 1·64
Hakgala	—	—	—	—	—	—	—	—	—	—
Hambantota	86·4	+0·4	73·0	0	74	88	5·9	3·18	6	+ 1·72
Jaffna	86·2	+0·6	72·6	+0·2	69	90	5·8	0·97	2	— 0·49
Kandy	87·8	+0·8	67·3	+0·4	63	87	5·9	2·30	9	— 0·01
Kurunegala	90·8	+0·7	69·7	+0·1	61	90	4·6	3·26	10	+ 1·27
Ratmalana	87·4	—	71·2	—	69	90	5·0	10·59	5	
Mannar	86·3	0	74·1	+0·4	71	88	4·9	1·12	3	— 0·58
Nuwara Eliya	69·6	0	46·5	+1·7	53	69	5·0	5·60	11	+ 3·61
Puttalam	89·2	+0·8	70·6	+0·3	66	93	5·0	3·04	4	+ 1·67
Ratnapura	91·6	0	71·5	+0·2	66	93	6·0	7·45	10	+ 2·15
Talawakele	76·6	+0·1	54·5	0	58	75	3·5	2·07	9	+ 0·10
Trincomalee	83·0	+0·4	76·4	+0·6	76	82	5·6	4·16	6	+ 1·51

WEATHER SUMMARY—FEBRUARY, 1950

Comparatively heavy rain was experienced in the south-western parts of the Island in February, several stations in and around Colombo creating new records for February. Thus, 13.56 inches at Maligakande is the highest February total in 57 years, the previous highest being 8.41 inches in 1927. Similarly, 11.81 inches at Elie House is the highest in 31 years (previous highest 6.80 inches in 1938), 11.48 inches at Colombo Fort the highest in 81 years (previous highest 9.63 inches in 1937), and 10.60 inches at the Observatory the highest in 43 years (previous highest 7.88 inches in 1944). The monthly totals in the south-western parts generally ranged from 5 to 10 inches.

Totals over 5 inches were also recorded at several stations on the eastern and north-eastern slopes of the hills and in the neighbourhood of Batticaloa. The highest monthly totals were 14.63 inches at Kellie Estate, 13.56 inches at Maligakande, 13.39 inches at Mayfair Estate and 13.37 inches at Chesterford Estate. Least rain was experienced in the western parts of Northern Province, where the totals were below 2 inches.

Rainfall was above normal over a large portion of the Island. The largest excesses were found chiefly in the neighbourhood of Colombo, and included 11.15 inches at Maligakande, 10.05 inches at Elie House, and 10.88 inches at Kellie Estate. The greatest deficits were 5.21 inches at St. Martin's (Lower) Estate, 3.97 inches at Hendon Estate and 3.82 inches at Opata.

There were 12 daily falls over five inches in February, the highest being 6.66 inches at Eheliyagoda on the 22nd.

Ground frost was reported from Kandapola on the 3rd, 7th, 10th, 12th and 27th. A hailstorm was reported from Pattipola on the 22nd.

During the first two weeks of the month the weather was generally bright. On the 8th evening, however, a very violent thunderstorm accompanied by exceptionally strong winds hit the village of Gintota near Galle, causing considerable damage to house and property. A large number of trees were torn off their roots and strewn about the village dislocating traffic. Over a hundred houses were seriously damaged rendering about 500 people homeless.

From the 16th rainfall was fairly frequent and occasionally widespread. Moderately heavy rain was experienced in the south-western parts on the 22nd, when several stations recorded falls over 3 inches.

Temperatures were mainly above normal. The highest temperature recorded in the shade was 96.3° at Ratnapura on the 13th while the lowest temperature for a low country station was 60.7° at Anuradhapura on the 4th. The lowest temperature for the whole Island was 32.6° at Nuwara Eliya on the 1st. Humidities were of the order of 70% by day and 90% by night cloud amounts were above average. Wind strength was mainly below normal, the prevailing direction being north-easterly:

D. T. E. DASSANAYAKE,
Director.

METEOROLOGICAL REPORT, MARCH, 1950

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		In.		In.
Agalawatta	90·2	+0·2	71·7	—0·4	78	98	5·4	9·51	15	— 0·62
Anuradhapura	90·3	—0·9	71·5	—0·1	65	95	4·2	3·73	10	— 0·42
Badulla	81·8	—0·6	64·5	+0·3	70	94	4·5	4·74	8	— 0·31
Batticaloa	84·8	—0·6	75·7	+0·8	78	91	5·2	7·59	7	+ 4·12
Colombo	87·8	—0·2	74·9	+0·9	74	93	4·8	7·64	13	+ 2·98
Diyatalawa	76·7	—0·6	58·2	+0·1	69	91	5·6	4·37	10	— 0·52
Galle	86·9	+0·5	75·4	+0·4	75	91	5·7	3·95	11	— 1·36
Hakgala	—	—	—	—	—	—	—	—	—	—
Hambantota	87·4	+0·6	75·1	+0·9	74	91	5·2	0·61	4	— 2·78
Jaffna	89·5	+0·9	76·9	+1·1	68	86	5·1	0·67	2	— 0·91
Kandy	89·0	+0·1	69·5	+1·0	64	92	5·4	2·70	11	— 3·14
Kurunegala	91·2	—1·7	72·8	+0·8	66	93	4·6	4·81	14	— 1·47
Ratmalana	87·8	—	74·0	—	71	93	4·9	8·51	11	—
Mannar	89·7	+0·4	76·5	+1·3	70	88	3·8	1·49	5	— 0·35
Nuwara Eliya	70·4	—0·5	47·0	+0·8	58	72	4·9	3·91	10	— 0·18
Puttalam	90·0	+0·1	73·8	+0·9	69	93	4·3	1·74	6	— 1·34
Ratnapura	92·5	+0·5	72·7	+0·2	70	93	5·8	11·38	13	+ 1·00
Talawakele	77·6	—0·3	55·5	+0·2	64	79	3·5	1·83	11	— 2·79
Trincomalee	85·6	+0·2	77·6	+1·2	75	86	4·6	0·62	4	— 1·68

WEATHER SUMMARY—MARCH, 1950

Rainfall in March was generally below normal over the greater part of the Island, excesses being mainly confined to the Batticaloa District and the north-eastern slopes of the hills. The largest deficits were 9.42 inches at Udahena Estate, 8.26 inches at Meeriabedde Estate and 7.58 inches at Sunderland Estate, while the largest excesses were 8.41 inches at Viragoda, 8.34 inches at Rukam and 7.89 inches at Lahugala.

The largest monthly totals were 19.23 inches at Millawa, 16.09 inches at Opata, and 15.17 inches at Detenagalla Estate. In the south-western parts and on the east side, monthly totals generally ranged from five to ten inches. Least rain occurred in the north and in the neighbourhood of Hambantota, where monthly totals were below two inches.

There were five daily falls over five inches during the month, the highest being 5.85 inches at Vaganeri on the 2nd.

Local thunder activity was in evidence, and rain was experienced mainly in the south-western parts, frequently during the first nine days but rather occasionally thereafter.

Temperatures were about normal by day, and above normal by night. The highest temperature recorded in the shade was 96.2° at Ratnapura on the 15th, while the lowest temperature for a low-country station was 64.8° at Anuradhapura on the 31st. The lowest temperature for the whole Island was 37.6° at Nuwara Eliya on the 15th.

Humidities were of the order of 70 per cent. by day and over 90 per cent. by night. Cloud amounts were above average. Wind strength was about normal, the direction being variable.

D. T. E. Dassanayake,
Director.

Rubber Research Scheme (Ceylon)

Release of Malayan Clones of the 500 series in Ceylon

Negotiations between the Rubber Research Institutes in Malaya and in Ceylon concerning exchange of clones are now reaching the final stages and the Rubber Research Scheme, Ceylon, hopes to be able to offer the RRI, Malaya, 500 series of clones for release in Ceylon in the very near future.

Budwood will be sold, under agreement, at a pric of Rs. 7 per yard.

Supplies of budwood are limited at the moment, but steps are being taken to ensure ample supplies by the end of the year.

It is proposed to distribute the available supplies of budwood among intending purchasers as soon as negotiations are completed, and to offer their full requirements later in the year.